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Supplemental Electronic In-Cab Truck Displays: An Inventory of Devices and Approaches to Their Evaluation

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16. Abstract

Todays medium-heavy truck driver, in many situations, operates under a heavy visual and attention workload. The driver's primary task is to maneuver his vehicle safely to its destination--a task which requires, at times, virtually uninterrupted visual monitoring of the roadway and relevant traffic events. Over the past few years there has been significant growth in the availability and use of supplemental electronic display devices. Most are clearly of benefit to drivers or fleet operators by virtue of their enhancement of operating efficiency, lower operating cost, driver control and maintenance scheduling, to list but a few. The inherent complexity of the driver-user/device interface, however, may be such that use of such devices during driving will decrease safety by increasing crash involvement, since they compete with the primary task of continuous roadway monitoring.

A study was undertaken to 1) inventory current and near-term electronic supplemental in-cab displays, 2) estimate their use in the 1990s by truck type, and 3) identify alternative strategies for their evaluation relative to their compatibility with safe truck operation. Over 50 supplemental in-cab devices were identified and described and are classified under the following headings:

Single/Integrated Display Systems;
Vehicle Information Systems;
Vehicle Navigation Systems;
Vehicle Positioning Systems;
Text Communication Systems, and
Vehicle Safety Systems.

Visual, motor and cognitive processing demand on the driver/user was estimated. A preliminary examination indicates that many devices impose a very heavy demand on the user and are designed to be used during driving, a situation which clearly will lead to decreased truck safety. The anticipated proliferation of such devices will no doubt lead to a broad highway safety problem.

Short and long range objectives and safety evaluation strategies are outlined and a plan for research to describe and quantify current truck driver workload, fundamental to any subsequent safety evaluation, is presented.

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ABSTRACT

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SUPPLEMENTAL IN-CAB DISPLAY INVENTORY AND EVALUATION

1.0 BACKGROUND AND ORGANIZATION

Recent developments in microcomputer and associated electronic technology have resulted in the current or near term availability of numerous sensing, processing and display systems for use in medium-heavy trucks. Virtually any vehicle-related parameter which can be sensed or measured can be processed and displayed on such an in-cab device. In addition, information originating external to the vehicle can be received and displayed in the form of graphics or text. Futuristic automotive literature focusing on vehicles of the near future, in fact, propose to display just about anything one can imagine, including computerized shopping and entertainment guides in motor vehicles.

The primary task of a driver is safe vehicle operation within its operating environment. All other tasks are secondary. Current in-cab displays and the developing system displays under investigation here mostly involve secondary tasks which can and do compete with the primary task of safe vehicle operation. While some such displays probably can be effectively and safely time-shared with the primary task, many most likely, cannot. Their associated benefits of improved efficiency, comfort, convenience and economy could decrease operating safety below current levels.

1.1 Purpose

The overall purpose of the study was to identify and describe currently available and near term supplementary medium-heavy truck in-cab displays and to develop approaches to their evaluation, relative to safety of use during driving.

Phase I involved a survey of technical and product sales literature in order to 1) inventory current and realistic near-term future truck supplemental in-cab displays and, 2) identify the types and numbers of vehicles which might use such devices. Phase II involved the development of

1) a near-term 2-year plan for evaluating the effect of in-cab devices on driving safety and, 2) a more comprehensive 5-year long range device evaluation approach.

1.2 Organization

The results of the study are organized into 7 sections. Following introductory Chapter 1, Chapter 2 describes the survey method and presents an inventory of in-cab devices which were identified. Chapter 3 describes the method used and provides preliminary estimates of 1992 in-cab device use by truck body type in the U.S. Chapter 4 describes the in-cab device/driver interface displays/controls and information processing, driver load and truck activity during use. Chapter 5 describes a method to obtain baseline driver workload measures and short and long term alternative evaluation approaches. Chapter 6 summarizes conclusions and recommendations of the study. References are contained in Chapter 7

2.0 INVENTORY OF IN-CAB DISPLAY DEVICES

2.1 Method

Trade publication periodicals, the SAE cumulative index and the Highway Safety Research Index formed the basis for the review. Articles, advertisements and new product descriptions were retrieved beginning with 1987 year end issues. All citations describing a device, not currently considered conventional truck instrumentation, which required driver visual monitoring and/or manual control interaction with the device were reviewed. Preceding issues of trade publications were successively screened, typically 3-4 years, until no unique devices were identified. The review focused on devices in or nearly in production and those with a reasonable likelihood of being available to the trucking or automotive industry within the next few years. Excluded from consideration were those which, in the staff's opinion, were fundamentally futuristic concepts having virtually no realistic near-term likelihood of implementation or applicability to the truck industry.

The following periodical publications were reviewed. Those typically yielding the most in-cab device citations are noted by an asterisk.

Automotive Fleet

Fleet Owner*

Truck and Off-Highway Industries

Wards Auto World

Heavy Duty Trucking*

GO West Magazine for Trucking Management*

Automotive Industries

Automotive Engineer

Automotive News

International Journal of Vehicle Design

Journal of Transportation Engineering

Transportation Quarterly

Transportation Research (Series)

Commercial Carrier Journal*

Automotive Engineering*

Copies of product brochures, sales literature, specifications and articles describing fleet-user experiences were obtained by contacting manufacturers or representatives by telephone or mail. Literature was obtained for virtually all "major" devices. However, contact with several of the smaller manufacturers could not be made and desired materials were not obtained. While it appeared that most systems were identified, a few others will no doubt surface in the near future. These should be integrated into the inventory as necessary to keep it up to date.

2.2 Classification

Product literature was reviewed in order to develop a classification scheme into which devices having common functions could readily be grouped. Six categories of in-cab displays were established:

I) Single/Integrated Displays;

II) Text Communications Systems;

III) Vehicle Information Systems;

IV) Vehicle Navigation Systems;

V) Vehicle Tracking Systems, and

VI) Vehicle Safety Systems.

2.3 Description of In-Cab Classifications

Over fifty in-cab systems have been identified. They represent the majority of those in the population of interest and are certainly representative of the types available at present and in the near future. The six categories are summarized below followed by a description of each device. Actual product brochures and literature providing detailed device information are enclosed as a separate appendix.

2.3.1 Single/Integrated Displays

The rapid growth of microcomputer capability has led to numerous single/multi-function displays for heavy trucks. Typically, the wide variety of

vehicle and engine functions which can be sensed are computer processed and displayed on multi-function displays as selected by a driver. Some functions can be sequentially and/or simultaneously displayed as desired on an integrated dashboard display. Marmon Motors and PACCAR have developed such concepts and the latter offers an integrated display as an option on conventional trucks. Low cost electronics and a variety of software should result in a proliferation of such display systems in the near future. Also, limited function systems which sense and display one or two specific kinds of information such as axle weight, cargo status (refrigeration) and cruise control or retarder status are available. Other such devices which provide unique information useful to only a limited number of specific truck cargo or operational situations are also available.

2.3.2 Text Communication Systems

While radio continues to be the primary in-vehicle mode of communication between trucks and a central dispatch unit, several digital text communication systems are presently in use. One system permits dispatch to send digital text information to a driver informing him of a pick-up address, package type, status etc. A driver responds using a keyboard. An in-cab CRT is used as the display.

The other system is a single two-line message display with dedicated pushbutton response keys. According to drivers, the former system originally permitted display/control interaction while the vehicle was in motion but "problems" resulted in blanking the system. The driver is advised of a message and now must stop to obtain it.

2.3.3 Vehicle Information Systems

The largest category of devices is comprised of some 17 trip recorder type systems which have basically replaced the older tachograph. These devices are all quite similar to one another in that they all provide for automatic recording of vehicle data and engine functions including speed, RPM and stops. All also permit driver data entry, including fuel purchase and state line crossing and most permit call-up and viewing of displayed vehicle/engine information by the driver. Displays are typically digital and

data entry is via menu driven procedures using full or limited push-button keypads or keyboards.

These devices are currently in-use by many fleets and operators cite benefits in terms of driver control, maintenance, scheduling, fuel economy, reduced paperwork and management report generation.

2.3.4 Vehicle Position Systems

Four vehicle positioning systems were identified. These systems typically employ dead-reckoning or satellite technology to enable a central dispatch unit to constantly monitor the location of a truck fleet on a map display. Drivers typically can also enter information for transmission to dispatch on a keyboard. Such data include load status and ETA, i.e., data useful for re-routing and real-time scheduling.

Most of these devices have been tested, if only on a small scale, but some are actually in-use by a few fleets. They have proven useful in re-routing vehicles, reducing fleet size, increasing fuel economy through efficiency and for the retrieval of stolen vehicles.

2.3.5 Vehicle Navigation Systems

Vehicle Navigation Systems are similar to tracking systems with the addition of an in-cab navigation display. Conceptually, these systems display maps of a driver's selected area and scale and permit driver entry of destination. Optimum route is shown on the map display from current location. Except for the ETAK Navigator most are in some stage of ongoing development and no precise configuration of the driver interface appears to have been established. The Department of Transportation is currently planning a study to evaluate the effectiveness of such devices for navigating in city traffic environments by integrating real time traffic information into the map display.

2.3.6 Vehicle Safety Systems

Safety systems are comprised of video CCTV or sonar/radar devices which provide information regarding objects in a vehicles' blind area. Ten such

systems were identified. In the case of video systems these devices display an area on a CRT. Other electronic devices provide an analog or simple visual and/or audio warning of objects in a sensor field.

The use of safety systems by the trucking industry appears very limited with only a few applications observed, notably in special purpose buses and high cost motor homes. The benefits of such devices appear unproven and the initial high cost and cabling compatibility between tractors and multiple trailer units may account for the apparent low acceptance of such devices.

2.4 Summary Description of In-Cab Display Devices

2.4.1 Integrated and Single Displays

CHARLIE (Retarder Control): Camcam, Inc.

The CHARLIE system is comprised of sensors and a control system for driver manual control of engine compression retarders. The in-cab system provides a set of switches to be used by the driver to select retarder control logic suited to existing driving conditions and for manual override. A simple status lamp indicates system state. (#211)

EZ WEIGH (Load Monitor): Martronic Engineering, Inc.

The "EZ" WEIGH system is an on board load monitoring device which calculates and digitally displays gross weight of a tractor/trailer. Using a simple switch, separate axle readings can be selected for driver display on an LED. (#204)

FUEL TACH (Fuel Consumption): Floscan Instruments

The FUEL TACH device is a simple analog gauge display employing a dial and pointer to show instantaneous fuel efficiency gain/loss and a digital display showing trip average miles per gallon. The driver interface involves only the display as no driver input is required. (#225)

CARGO SAVER II (Reefer Monitor): Cargo Saver Inc.

CARGO SAVER II is a refrigerated cargo container temperature monitor employing an in-cab console. Control switches permit driver temperature range adjustments. An audio alarm indicates out of tolerance conditions and a digital display indicates temperature. No detailed specifications were obtained. (#244)

T MACS (Reefer Monitor): Brandstedt Controls Corp.

The T MAC/T TICKER systems are refrigeration monitoring and recording devices. Controls and displays are located not in-cab but on the cargo body. Temperature/status is displayed for view in the driver's rear view mirror. Displayed information can be reversed for mirror viewing. (#261)

DIGITAL TEMPERATURE CONTROL SYSTEM (Reefer Monitor): Carrier Transcold

This system is a refrigeration control/monitoring device with all controls and indicators mounted outside the cab on the truck body. Displays, however, are visible to the driver via his side rear view mirror. System status and out of tolerance conditions are displayed. (#258)

MODE PRO IV & V (Reefer Monitor): Etron Data

Mode Pro IV is a single probe sensor system with in-cab display and controls. A selector switch is used by the driver to select time delay, and upper and lower temperature limits. A digital display shows temperature and an auditory alarm indicates pre set out of tolerance conditions (#251A). Mode Pro II has three probes and similar controls and displays (#251B).

DB212 DIGITAL/BARGRAPH (Engine Functions): Dixson Inc.

The DB212 DIGITAL/BARGRAPH is an engine monitoring and display system which provides for the display of seven engine parameters.

Analog bargraphs display fuel level and oil temperature. A digital display of five additional functions including RPM, oil pressure, water temperature, etc. are selected using a single pushbutton control (See Figure 2-1). (#253)

ETEC II (Cruise Control): TRW

ETEC II is a preprogrammed engine control system. Engine and vehicle speed sensors are read by a control unit which automatically controls fuel flow. A diagnostic unit, with controls and displays, are used only by maintenance personnel and presumably not during driving. (#255)

EDM (Electronic Diesel Fuel Monitor): ARGO Instruments

The EDM provides a continuous digital readout to a driver of four selectable fuel related functions. It can be used alone or in combination with the ARGO tachograph or FMS on-board computer. The four functions selected by a single pushbutton are 1) average MPG, 2) instantaneous MPG, 3) total gallons since reset and 4) total miles since reset. (#260)

Electronic Dash: U.S. Gauge (Ametak/ Paccar)

The electronic dash is comprised of a large LCD panel and separate keypad. Using the keypad a driver can select various functions and view bar-graph and digital displays/readouts. Seventeen functions, e.g., outside temperature, speed RPM, average MPG, can be selected. Warning lamps are included and up to 10 regular gauges can be added. The system is apparently available as optional equipment on 1988 Peterbuilt and Kenworth conventional trucks replacing usual dash displays. (#227)

Electronic Dashboard: Marmon Motor Co.

The Marmon Electronic Dashboard is a vacuum tube fluorescent display which simultaneously displays, in digital format, fourteen engine and other conventional functions. Other miscellaneous

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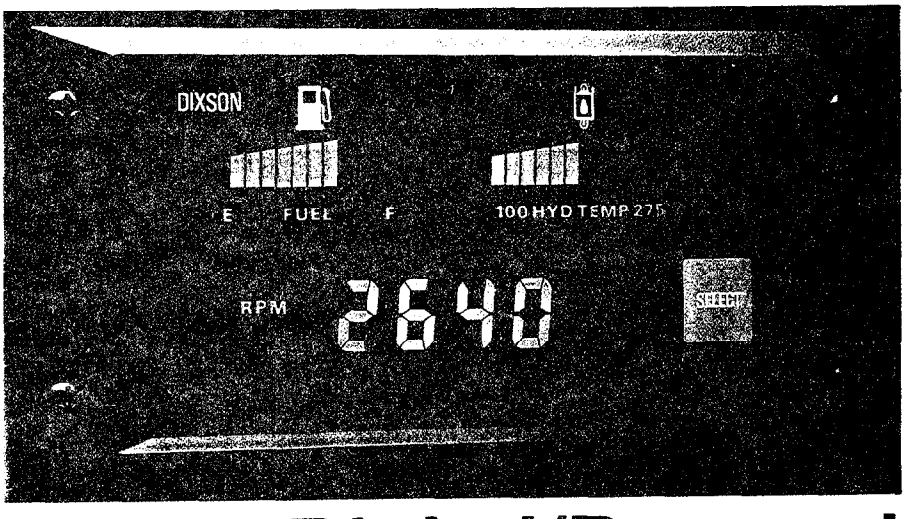

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Figure 2-1 Sample Single / Integrated Display

displays indicate turn signal and vehicle lighting status while audio alarms and status lights indicate excess conditions. The system was to be an option on all Marmon trucks but, according to Marmon, development problems have prevented its immediate implementation. (#216)

DDEC-II Advanced Electronic Diesel Control: General Motors

The DDEC-II is an on-board computer type system for sensing and displaying engine functions to a driver. The system also provides for engine diagnosis and off-line vehicle management reports. Current availability is unknown. (#243)

VIP (Vehicle Instrumentation and Protection): KYSOR

In the VIP, an on-board computer monitors vehicle engine functions as well as turn signal and miscellaneous other functions, and provides a visual and auditory display of out of tolerance conditions. No driver input is required since it is limited to simple status information. (#248)

AUDIT (Automotive Data Information Terminal): Javalena Corp.

AUDIT appears to be a developing system concept employing one or more small in-dash CRT's to display up to 41 functions selected by a driver. An on-board computer monitors sensor input such as engine functions, tank and fluid levels, etc, and digitally displays information to the driver. It appears to be in a preliminary development stage with no specific configuration as yet established. The appeal seems to be that hardware can remain constant over years of model changes with only software modification necessary to change display outputs. (#226B)

2.4.2 Digital Communication Systems

Computerized Taxi Dispatch (MDI 7031): Mobile Data Inter.

The MDI 7031 is a dispatch system which transmits text messages to

vehicle drivers (at present principally to taxi cab drivers). Central dispatch enters messages into a base computer which automatically selects a nearby available vehicle and transmits a pick-up address which is then sent to and displayed in the selected vehicle. Two lines of text can be displayed. The driver responds using an array of dedicated pushbuttons. While its principal use is currently in taxis, the potential applicability to service industry trucks is clear. (#262)

MDI 9031 (Two-Way Text Communication): Mobile Data Inter.

The MDI 9031 is primarily a 2-way text communication system. It is comprised of a 5-inch CRT display, full typewriter keyboard and function select pushbuttons. The CRT can display up to 10 lines of 32 characters. Up to 100 message lines can be stored and viewed. The keyboard is illuminated. The MDI 9031 is currently in use by numerous U.S. and Canadian fire and police departments, public utilities and service businesses including Federal Express. Some early installations permitted use during vehicle driving but "problems" (crashes?) have resulted in limiting use to periods when the engine is off (See Figure 2-2). (#263)

2.4.3 Vehicle Information Systems

FLEET DATA MASTER: Advanced Recording Instruments, Inc.

Fleet Data Master is an on-board computer trip recorder type system which automatically records vehicle sensor input primarily for subsequent off-site management report generation. The Driver Input Unit (DIU) is comprised of a digital display and 20 pushbutton keyboard. The keyboard has 5 dedicated function buttons, 5 additional function buttons and 10 numeric keys. A driver selects functions and enters up to 99 "recalled" codes. Sensor input such as RPM, speed, oil pressure and water temperature as well as data entries, can be selected for digital display (See Figure 2-3). (#209)

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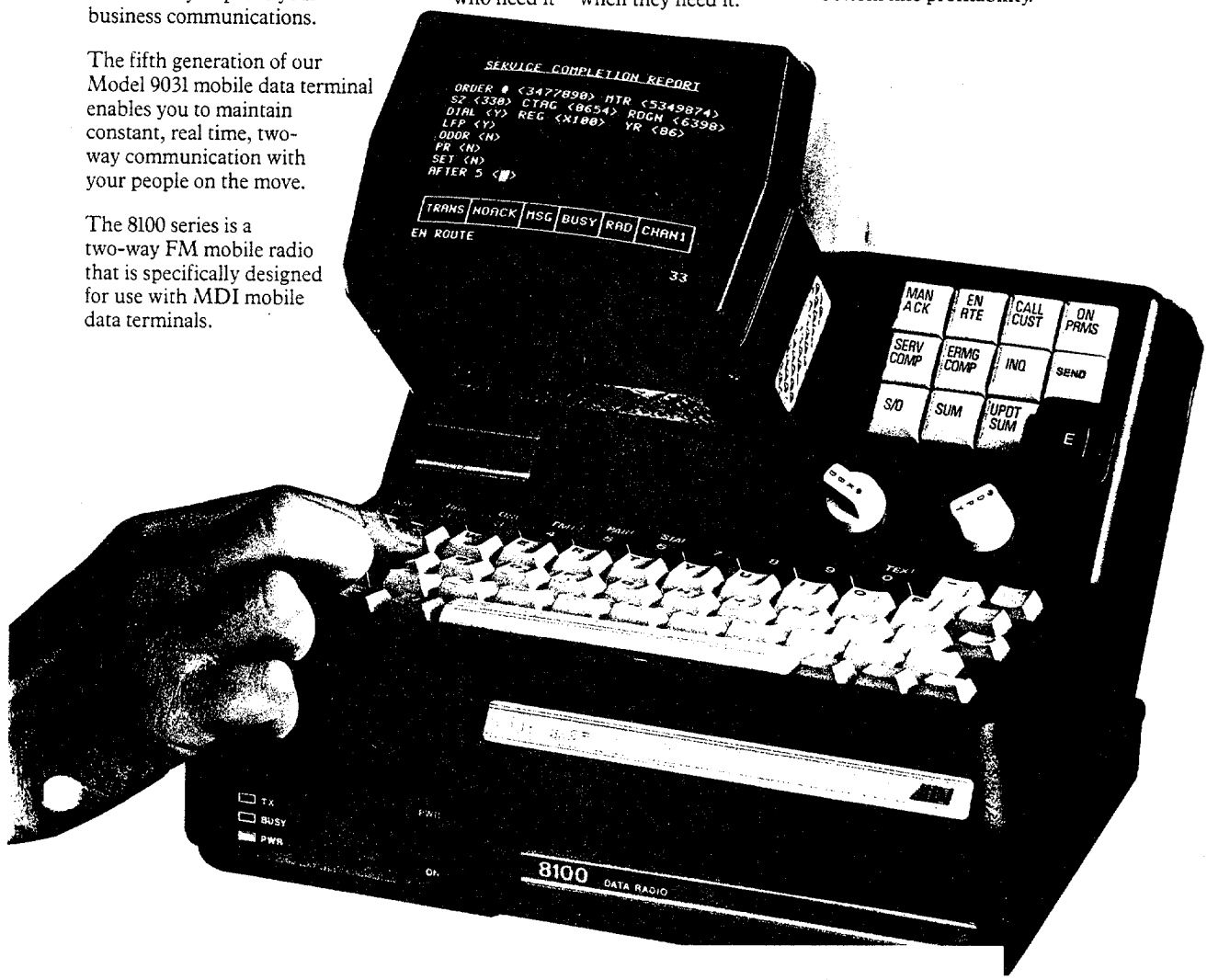

Figure 2-2 Sample Text Communication System (Full Data Entry Keyboard)

UNIPARS (Monitoring and On-Board Weighing System): Unit Rig Equipment Co.

The Monitoring and Weighing system is an on-board monitoring and weighing type. It monitors and records up to 64 functions, with options. Functions can be viewed in-cab and an optional printer permits in-cab printing of some reports as well as off-site report generation. An optional warning system alerts the driver to out of tolerance conditions. (#213)

SILENT 1000 (Trip Recorder): Centrodyne Corp. of America

The Silent 1000 is an on-board trip recorder type system which automatically records vehicle sensor input primarily for subsequent off-site report generation. A Vehicle Mounted Unit (VMU) is comprised of two digital displays and four function select keys. A driver can select for viewing 1) speed or RPM or 2) fuel consumption or time of day on the two displays. Visual and auditory alarms are automatically activated when preselected speed or RPM limits are exceeded. Driver can also select functions and enter codes such as border crossings and driver identification data. In addition, the system calculates statistics such as average speed, fuel used, and average RPM and these can be displayed to the driver. The system can, however, be preset to preclude viewing statistics in the cab. (#214)

DATA-COM (Trip Recorder): Anchron, Inc.

The DATA-COM on-board microprocessor records engine and other sensor inputs. A hand-held or dash mounted keyboard/display device permits driver data input. The digital display shows instantaneous or average MPG and reports ca be printed off-site for subsequent analysis by management. No detailed specifications were obtained on DATA-COM. (#220)

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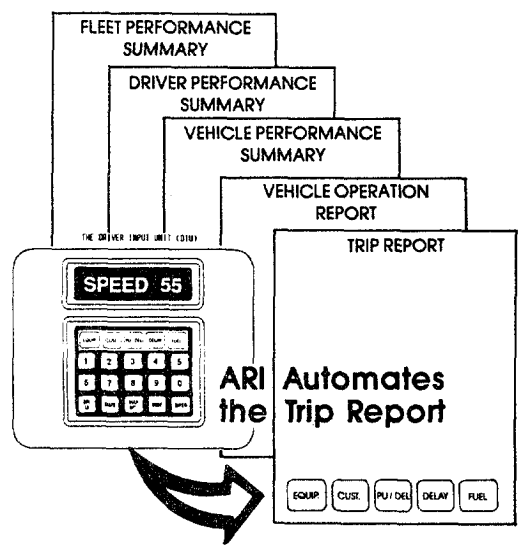

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Figure 2-3 Sample Vehicle Information System Displays and Controls

SYSTEM 7000 (Trip Recorder): Stemco Instruments

The SYSTEM 7000 is an on-board computer system which automatically records preselected vehicle information primarily for subsequent off-site report generation. A hand-held size data entry terminal permits the driver to select specific functions and to enter coded and other alphanumeric information using a pushbutton keyboard. A digital display allows the driver to view entries made and to select various functions such as speed and RPM for viewing. Data entry utilizes driver prompts and a computer driven menu format. The system can be preprogrammed to preclude driver selection of certain functions while the vehicle is in operation. (#222)

DRIVER INFORMATION SYSTEM: XATA

XATA Driver Information System is an on-board computer system which is termed an "electronic secretary" for truck drivers. This trip recorder type system automatically records vehicle sensor input for management reports. The driver uses a touch screen to enter and to call up data. Several functions can be digitally displayed simultaneously and the touch screen can be used as a calculator (See Figure 2-4). (#240)

TC-1 (Trip Recorder): Transcom, Inc.

The TC-1 is a "driver oriented" on-board computer system for recording vehicle information. The in-cab display permits driver selection of functions on a 2-line LED digital display. A 15 key keyboard is used for data entry and function selection. No detailed specifications for the TC-1 were obtained. (#242)

ELECTRONIC RECORDER (Automatic Trip Recorder): TRW

The Electronic Recorder is an on-board computer system used only for recording of vehicle functions for off-site management report generation. No driver interface is available. (#249)

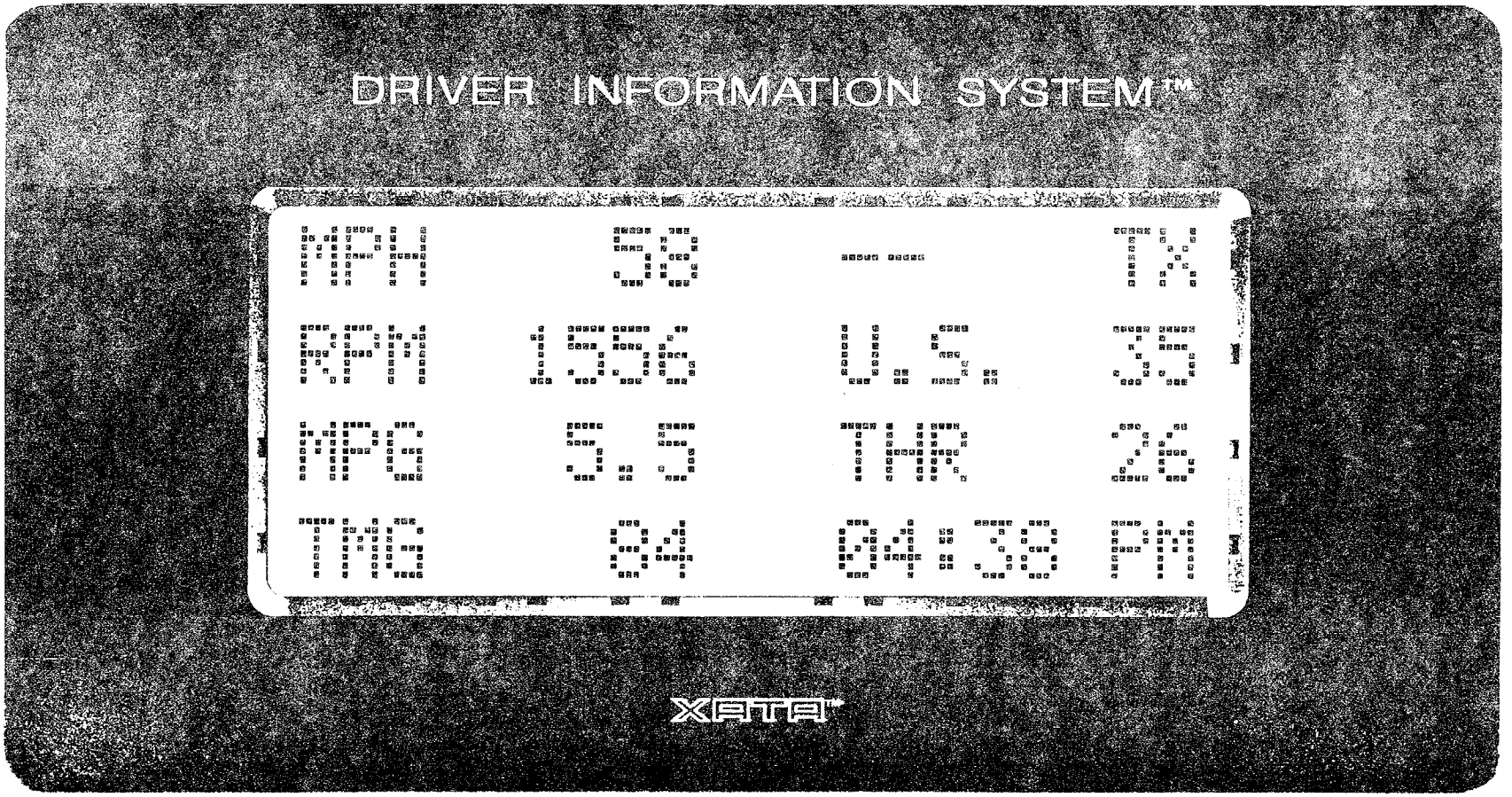


Figure 2-4 Sample Vehicle Information System (Touchscreen)

FMSS 1330 (Trip Recorder): Argo Instruments

The FMSS 1330 is an on-board computer trip recorder which automatically records vehicle sensor input primarily for off-site management report generation. A Driver Input Device permits the driver to select from among 5 predetermined functions including location, state and fuel and to enter prescribed coded information for each. Codes must be recalled by the driver. Twelve on/off switches are provided in the basic model. An optional Driver Input Module, which is the size of a hand-held calculator, is comprised of a 16 pushbutton keyboard and digital display. A driver can enter data by selecting from among the various functions and enter alphanumeric characters. (#207 A & B)

CADEC 100, 200 AND 300 (Trip Recorders): Cummins

The CADEC series of systems are on-board computer systems primarily for recording vehicle functions for off-site report generation. Three models are available (# 208 A & B):

1) The CADEC 100 provides only on/off status lamp warning display of idle or speed condition to a driver to prevent excess and to modify driving behavior. No controls are available for driver input.

2) The CADEC 200 provides a 20 character digital display and a pushbutton keyboard. The keyboard is comprised of 4 function keys, clear and enter keys and 10 numeric keys. A driver can select functions such as tolls, expenses, state lines and enter codes or values. Presumably the driver can monitor various functions being automatically recorded.

3) The CADEC 300 provides 10 function keys in addition to those available on the 200 model for additional data entry.

TRIPMASTER: Rockwell International

The Rockwell Tripmaster is an on-board computer trip recorder

which automatically records pre-selected sensor inputs for off-site report generation. Three optional modes of operation are available. Using the "Key Input Module" a driver simply logs on and off having no further interface with the device. Secondly, using the "Driver Input Control," however, he can select functions and enter data such as state, location and fuel with thumbwheel switches and an enter pushbutton. In the third mode, using a "Driver Keypad/Display," he can select functions and enter alphanumeric text and coded data using a 22 pushbutton hand held terminal and view text on a 32 character LCD display (See Figure 2-5). (#208 A & B & C)

MILOG (Recordkeeping): Vehicle Management Systems

MILOG is an in-vehicle recordkeeping system for periodic logging of vehicle use. The in-cab device is about the size of a mobile telephone and includes a digital display, tape printer and a 9-pushbutton keyboard. The system manually records and cumulates miles driven, date, purpose and similar vehicle use data for business recordkeeping. (#263)

AL 100 (Driver Information System): B P Bishop Automotive Products

The AL 100 is an on-board computer driver information system which automatically records or calculates limited vehicle data such as idle time and average speed and permits manual input of numerous events and event times. The latter include standby time, breaks etc. A hand held keyboard comprised of 10 keys and a digital display are used to call-up functions and enter data. An on-board printer can print selected data on paper tape. (#264)

2.4.4 Vehicle Navigation Systems

TRUCK TRACKER: IDATA SYSTEMS

TRUCK TRACKER is a truck location tracking system using a vehicle based Loran C receiver and transmitter, console, software and

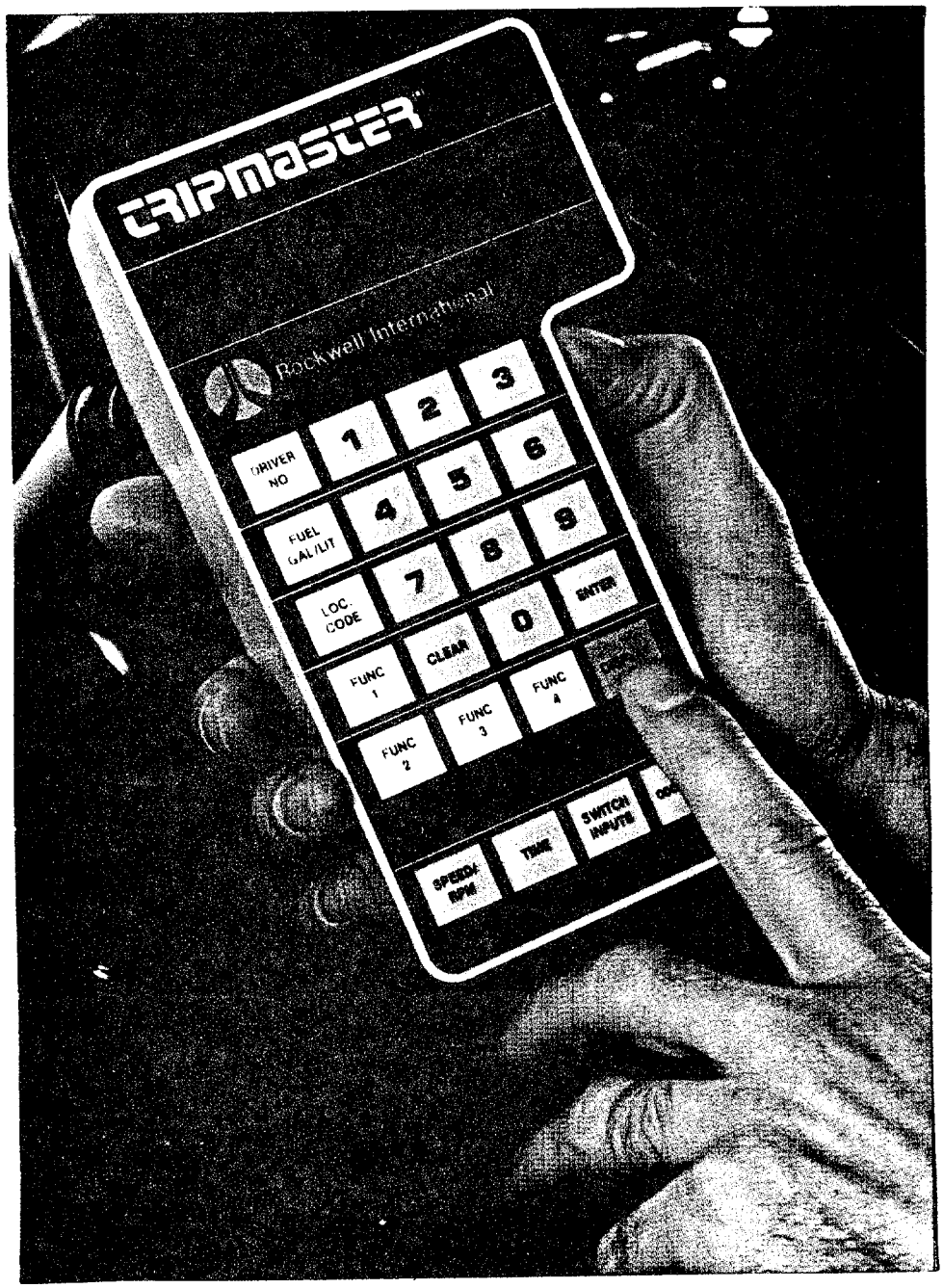


Figure 2-5 Sample Vehicle Information System (Digital Entry)

monitor. Apparently an optional in-cab navigation map display is available for use by the driver. No detailed specifications were obtained for TRUCK TRACKER. (#228)

NAV-COM (Truck Locating/Navigation): Magnavox

NAV-COM is an automatic system for locating, communicating with and for managing a fleet of vehicles. The system employs radio communications and uses dead reckoning techniques for vehicle location. A video mapping system can also be fitted in the vehicle to show actual position relative to streets and landmarks." No detailed specifications were obtained. (#246)

OMNITRACS (Truck Locating/Navigation): Omninet Communications Services

The OMNITRACS system is a satellite based vehicle positioning and two way digital (non-voice) free form or preformatted message communications system. No specifications regarding in-cab controls or displays were obtained since it is apparently under development with availability anticipated in late 1988. Omninet has 34 irregular route truck companies under or nearly under contract at present. They expect to produce 30-50,000 units in the next 2-3 years at a cost of approximately $4-5,000 per unit. (#254)

ETAK Navigator: ETAK

The ETAK navigator is a dead reckoning/map correlation type system for automatic vehicle position tracking. It includes an in-cab CRT map display and keyboard for data entry. A driver enters destination and can then view a map of current location, roadways, and destination. A zoom feature permits selection of map scale. The ETAK Navigator also provides for two way digital communications between driver and dispatch. System cost is estimated at about $1,700 per unit. (#270)

NOTE: The visual load imposed by ETAK Navigator use during

automobile driving has recently been assessed. A re-analysis of that data is summarized in Section 4.5 along with other driver looking behavior measures.

2.4.5 Vehicle Tracking Systems

RDSS Radio Determination Satellite System: Sony Corp.

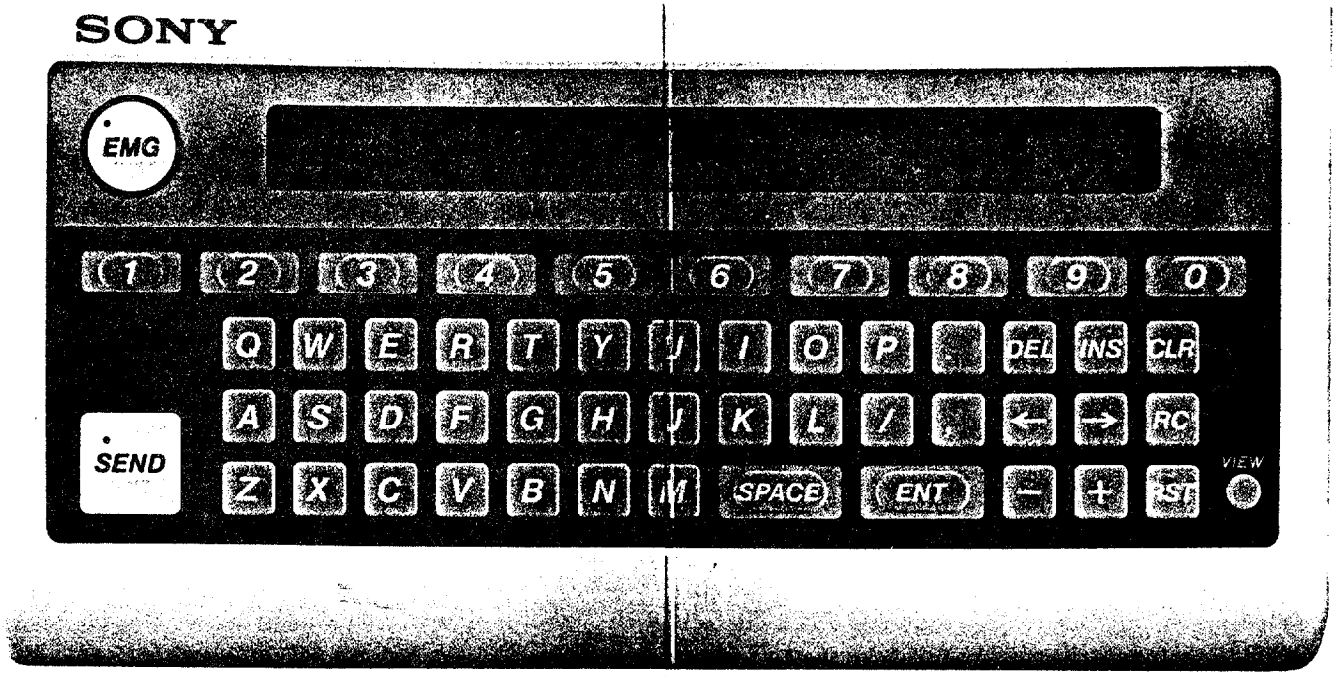
RDSS is an automatic vehicle position/tracking system. The Wayfarer Mobile Communication Unit automatically transmits, via vehicle antenna, vehicle position and various vehicle engine/status information to a central dispatch unit using the Loran C navigation network, GEOSTAR satellite and ground earth station links. The system operates in two modes--an automatic mode which does not involve a driver and in a manual mode in which a driver interacts with a menu driven display. He can select functions such as load, ETA and availability and enter alphanumeric text messages as desired using an 80 character LCD display and 55 key keyboard (See Figure 2-6). (#203)

II MORROW VTS (Vehicle Tracking): II Morrow, Inc.

The VTS is an automatic vehicle position/tracking system which also uses the Loran C system. While tracking is automatic, a driver, using one of two optional control consoles, can transmit to dispatch data such as loading, in route, etc., using pushbuttons. The optional consoles appear to be a 16 key panel and a set of pushbuttons for data entry. No navigation or position map is available in the cab. VTS is currently in use primarily by emergency, police, law enforcement and public utility vehicles and to a small extent in trucks. (#236)

VEHICLE POSITIONING SYSTEM: Rockwell International

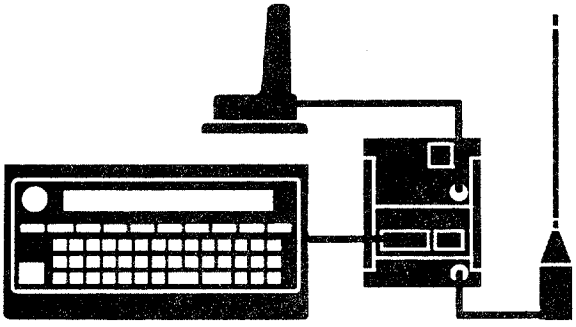
The Rockwell concept is a two way satellite communications and vehicle positioning system. No detailed specifications are available but the system appears to automatically transmit vehicle position via satellite to a map located at a central dispatch. It



THE MAIN UNIT

The brains of the Sony Wayfarer is the Main Unit, a "black box" that requires no attention from the driver. It can mount in the tool compartment or another unobtrusive location. It measures just 5⅞ (W) × 9⅞ (H) × 7⅛ (D) inches, but don't let the size fool you. The Main Unit contains all of the positioning, transmitting and computing electronics. For the easiest possible trouble-shooting, the Main Unit contains a built-in diagnostics program.

In addition to automatic vehicle location, the Main Unit can attach to vehicle sensors to transmit such on/off information as engine overheat, oil low, door open, reefer temperature too high, burglar alarms, and the like.

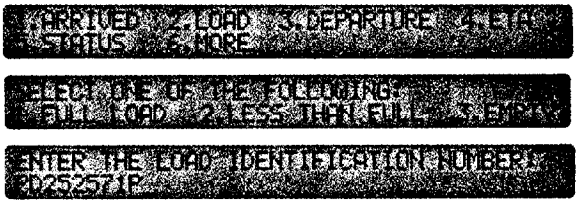


THE KEYBOARD/DISPLAY

At Sony, we believe a driver's time and attention is best spent driving. Not making unnecessary stops, not waiting for instructions or assistance, and definitely not leafing through instruction manuals, studying computer programs, or typing. That's why we designed the Wayfarer to transmit vehicle location and sensor readings automatically so the driver need not touch a

When the driver wants to send a message to central dispatch, the Wayfarer Keyboard/Display makes it quick and easy. The Display prompts the driver with a handy

"menu" of message types: ARRIVED, LOAD, DEPARTURE, ETA, STATUS, and OTHER. The driver can select LOAD, for example, at the touch of a single button. The next display prompts him for FULL, LESS THAN FULL, or EMPTY. If the driver selects either of the first two, he is then prompted to enter LOAD NUMBER, WEIGHT/CUBES/ or UNITS and load description.



In the same way, the driver can send off a quick ETA message based on prompts for DATE, TIME, and DESTINATION. Plus, the STATUS option includes prompts for HOURS AVAILABLE, ROAD CONDITION, WILL CALL, and FUEL.

Prompted step-by-step, the driver can send most messages in a matter of seconds. For breakdowns, emergencies, delays and special situations, the driver can always add his own comments in his own words.

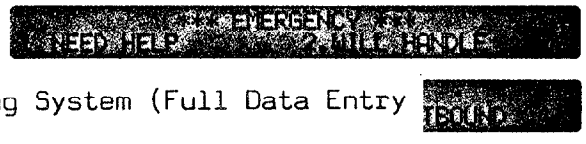


Figure 2-6 Sample Vehicle Tracking System (Full Data Entry Keyboard)

also permits two way communications between truck and dispatch. The system can also apparently extract information recorded by the Rockwell Tripmaster on board computer. Availability is anticipated for the early 1990s. (#256)

2.4.6 Vehicle Safety Systems

CAR VISION SYSTEMS-9300 (Video): Intec

The CAR VISION 9300 is comprised of a solid state video camera and in-cab video monitor. The camera is typically mounted at the rear of a vehicle having blind areas such as buses, trucks and RV's. In the standby mode the video monitor produces an image only when the vehicle transmission is placed into reverse gear. The driver can select brightness, contrast and day/night mode. It should be noted that the system electronics have been modified so that the monitor cannot be used to receive broadcast programming nor can it be connected to a VCR for recording playback.(# 205)

AUTOMOTIVE WATCHCAM (Video): Sony Security Systems

The WATCHCAM is a closed circuit video monitoring system to enhance "peripheral and rear vision" for drivers of heavy vehicles having blind areas. A four inch in-cab monitor showing the camera view is available for the driver. The system is priced at about $1,500. (#231)

EAGLE EYE (Backing/Passing): Chase Manufacturing, Inc.

EAGLE EYE is an electronic device which provides passing clearance and back-up warnings to a driver. An in-cab monitor provides visual and auditory warnings to alert as to "unsafe conditions." It is proposed as useful in avoiding right turn squeeze type accidents common to trucks. (#229)

CARDAR (Back-Up Warning): Yong Digital Electronics Co.

CARDAR is a proximity warning electronic sensor/display system

having a small in-cab console. It uses audio and two color visual lamp displays to alert a driver of other vehicles or objects which are "too close" when backing. (#238)

RETRO-GUARD (back-up warning): Dal Star Research, Inc.

RETRO-GUARD is an ultrasonic ranging device for use when backing vehicles with rear blind areas. A digital display indicates distance to objects in sensor range up to 10 feet. Audio alarms (discrete and continuous) are initiated when an object is within preset range. The device becomes operational only when the transmission is placed into reverse gear. (#241)

TATTLE TALE (back-up warning): Polytech Corp.

TATTLE TALE is a sonar "back-up protection" system which senses objects up to 16 feet from the rear of a vehicle. The in-cab control/display console shows the distance to rear objects and sounds an audio signal to alert the driver. (#245)

MODEL 750 REAR CAMERA VIDEO SYSTEM: JAVELINA CORP.

THE 750 SYSTEM is simply a closed circuit video system. A camera is mounted at the rear of a truck and a 5 inch monitor is available to the driver. No operating details were obtained. (#226A)

ELECTRONIC BACKING SYSTEM: Fleet Specialties

The ELECTRONIC BACKING SYSTEM is comprised of ultra sonic sensors located on the vehicle exterior which sense and display the presence of objects in blind areas. Two displays are available. An on-dash display flashes "danger front or rear" and sounds an alarm if an object is within sensor range. An alternative display is a linear analog type showing actual distance from 1 to 6 feet to an object in sensor range. (#247 A & B)

BACK SENSOR: Safety Technology, Inc.

The BACK SENSOR is a back-up warning system having a range extending from 8 inches to 20 feet. An in-cab analog dial type display indicates the distance to rear objects during backing. Rotary switches are used to select a warning range at which an audio alarm is activated. The device is priced at about $2,000. (#265)

3.0 POTENTIAL DEVICE USE BY THE TRUCKING INDUSTRY

In order to obtain an indication of the potential impact of the availability of the various in-cab devices inventoried, an attempt was made to 1) relate device type or category applicability to truck type and 2) estimate the near future (1992) device use by the truck population. The latter estimate of the use of devices by category and type of truck is based upon operational considerations such as truck type, fleet size, operating distance and apparent potential user cost/benefit.

3.1 Method

3.1.1 Estimate of the 1992 Medium-Heavy Truck Populations

The latest U.S. inventory of trucks--the 1982 Census of Transportation (1985)--which tabulates the U.S. truck population in various descriptive categories, formed the basis for estimating the numbers of medium-heavy trucks by body type on the road at the time of the 1982 census. The 1982 frequencies of single units, combinations and total trucks were tabulated by body type, using data from Table 8 of the Census report. These frequencies were adjusted by additional Table 8 data which identified the percentage of all trucks that are medium-heavy, i.e., excluding light trucks of less than 10,000 pounds. These adjusted medium-heavy 1982 truck frequencies were then increased by 25 percent as an estimate growth from 1982 to 1992.

The estimated 1992 frequencies of medium-heavy single units and combination trucks by body type are shown in Table 3-1. The overall estimate of 1992 medium-heavy trucks is 4.74 million with about one-third being combinations and two-thirds single units. The estimated frequency by discrete body type classifications of the "Census" are also shown in the Table.

3.1.2 Estimated Device Use by Truck Types

While the potential use of a device is influenced by truck type, estimates of its actual use is largely dependent upon fleet size, short vs

Table 3-1 Estimated 1992 Medium-Heavy Truck Population/ Description

BODY TYPE	AVE MILEAGE	FLEET SIZE (% > 20)	TOTAL TRUCKS	SINGLE UNITS	COMBINATIONS
GRAIN	8,000	4	237,500	205,000	32,500
WRECKER	9,000	3	37,500	37,500	0
YARD	9,000	38	11,250	1,250	10,000
UTILITIES/SERVICE	10,000	46	151,250	130,000	21,250
LIVESTOCK	13,000	4	95,000	73,750	21,250
PLATFORM (ALL TYPES)	13,000	13	1,453,750	1,112,500	341,250
DUMP	13,000	17	551,250	450,000	101,250
OILFIELD	16,000	11	71,250	38,750	32,500
OTHER	19,000	19	194,400	10,000	10,000
CRANE	13,000	25	56,250	47,500	8,750
GARBAGE	17,000	26	61,250	60,000	1,250
CONCRETE	12,000	50	63,750	62,500	1,250
BEVERAGE	14,000	63	93,750	77,500	16,250
POLE/LOGGING	22,000	11	71,250	38,750	32,500
CONTAINER/CARGO	28,000	30	13,750	7,500	6,250
TANKER (ALL TYPES)	28,000	36	333,750	215,000	118,750
VAN (ALL TYPES)	43,000	44	1,218,750	635,000	583,750
AUTO TRANSPORT	44,000	55	22,500	5,000	17,500
TOTALS			4,736,150	3,207,500	1,356,250

long haul operating range and mileage accrued per year. For example, larger fleets would be more likely to invest in a positioning system since initial cost is distributed over many more vehicles. Also, high mileage trucks have a greater need for maintenance which is more easily predicted and scheduled using trip recorder based management reports. Finally, short haul trucks making many inner city stops would benefit most from a map system while long haul trucks would benefit most from an automated log keeping trip recorder.

Table 3-2 presents an estimate of the proportion of trucks, by census defined body type, that will be using devices by type, by the year 1992. The estimates considered the applicability of a device to a truck type and the apparent benefits of a device to a fleet operator. In some cases the applicability and benefits were quite clear e.g., yard tractors do not need route guidance systems, while other estimates are more nearly educated guesses. The estimates presented should be reviewed by those familiar with truck operations and economics and the estimates refined as appropriate. Also, predictions must consider the likely future economy of the truck industry itself.

Table 3-3 is the product of Tables 3-1 and 3-2 and represents the estimated frequency of expected device use by truck body types and size. Again, the frequencies represent an assumed growth of 25 percent in the truck population between the last census of 1982 and 1992. The bottom row of Table 3-3 is an estimate of the total number of devices for single unit and combination trucks of all types.

3.2 Comments on Variables Underlying Frequency Estimation

The following section describes some of the many factors relevant to the task of estimating the near-future market for supplemental in-cab display devices. These include truck operations, potential costs/benefits to fleets in maintenance, driver control, fuel consumption, real time re-routing, etc. These considerations should be of assistance to those desiring to refine estimates of in-cab device use.

Table 3-2 Estimated 1992 Proportion of Truck Types Using Devices

DEVICE TYPE	SINGLE/INTEG. SYSTEMS		TEXT COMM. SYSTEMS		VEHICLE INFO. SYSTEMS		VEH. TRACKING SYSTEMS		NAVIGATION SYSTEMS		SAFETY SYSTEMS	
TRUCK TYPE	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.
BODY TYPE												
GRAIN	.10	.05	.05	.05	.10	.10	.05	.05	.00	.00	.02	.02
WRECKER	.10		.10		.10		.05		.05		.02	
YARD	.05		.00		.00		.00		.00		.02	
UTILITIES/SERVICE	.10	.10	.30	.30	.20	.30	.30	.20	.10	.05	.05	.00
LIVESTOCK	.05	.10	.00	.00	.10	.25	.05	.05	.00	.00	.00	.00
PLATFORM (ALL TYPES)	.10	.10	.05	.05	.20	.20	.10	.15	.05	.05	.02	.00
DUMP	.10	.10	.00	.00	.10	.20	.00	.00	.00	.00	.02	.02
OILFIELD	.10	.10	.00	.00	.10	.10	.00	.00	.00	.00	.02	.02
OTHER	.10	.10	.05	.05	.05	.05	.05	.05	.05	.05	.02	.02
CRANE	.05	.10	.00	.00	.10	.10	.00	.00	.00	.00	.02	.02
GARBAGE	.10	.10	.05	.00	.20	.20	.00	.00	.00	.00	.05	.02
CONCRETE	.10	.10	.05		.10	.10	.00	.00	.05	.05	.02	.02
BEVERAGE	.10	.10	.00	.05	.10	.10	.00	.00	.05	.05	.02	.00
POLE/LOGGING	.10	.10	.00	.00	.10	.20	.00	.00	.00	.00	.02	.02
CONTAINER/CARGO	.10	.10	.00	.00	.20	.30	.05	.05	.05	.05	.02	.02
TANKER (ALL TYPES)	.15	.10	.00	.00	.20	.30	.05	.05	.05	.05	.02	.02
VAN (ALL TYPES)	.10	.10	.20	.10	.30	.40	.10	.10	.10	.15	.05	.00
AUTO TRANSPORT	.10	.10	.00	.05	.30	.40	.05	.05	.05	.05	.02	.00

Table 3-3 Estimated 1992 In-Cab Device Use Frequency By Truck Type

DEVICE TYPE	SINGLE/INTEGRATED SYSTEMS		TEXT COMM. SYSTEMS		VEHICLE INFO. SYSTEMS		VEHICLE TRACKING SYSTEMS		NAVIGATION SYSTEMS		SAFETY SYSTEMS	
TRUCK TYPE	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.	SINGLE	COMB.
BODY TYPE												
GRAIN	20,500	1,625	10,250	1,625	20,500	3,250	10,250	1,625			4,100	650
WRECKER	3,750		3,750		3,750		1,875		1,875		750	
YARD	63										25	
UTILITIES/SERVICE	13,000	2,125	39,000	6,375	26,000	6,375	39,000	4,250	13,000	1,063	6,500	
LIVESTOCK	3,688	2,125			7,375	5,313	3,688	1,063				
PLATFORM (ALL TYPES)	111,250	34,125	55,625	17,063	222,500	68,250	111,250	51,188	55,625	17,063	22,250	
DUMP	45,000	10,125			45,000	20,250					9,000	2,025
OILFIELD	3,875	3,250			3,875	3,250					775	650
OTHER	1,000	1,000	500	500	500	500	500	500	500	500	200	200
CRANE	2,375	875			4,750	875					950	175
GARBAGE	6,000	125	3,000		12,000	250					3,000	25
CONCRETE	6,250	125	3,125		6,250	125			3,125	63	1,250	25
BEVERAGE	7,750	1,625		813	7,750	1,625			3,875	813	1,550	
POLE/LOGGING	3,875	3,250			3,875	6,500					775	650
CONTAINER/CARGO	750	625			1,500	1,875	375	313	375	313	150	125
TANKER (ALL TYPES)	32,250	11,875			43,000	35,625	10,750	5,938	10,750	5,938	4,300	2,375
VAN (ALL TYPES)	63,500	58,375	127,000	58,375	190,500	233,500	63,500	58,375	63,500	87,563	31,750	
AUTO TRANSPORT	500	1,750		875	1,500	7,000	250	875	250	875	100	
TOTALS	**325,376**	**133,000**	**242,250**	**85,626**	**600,625**	**394,563**	**241,438**	**124,127**	**152,875**	**114,191**	**87,425**	**6,900**

3.2.1 Single/Integrated Displays

Multi-function systems, typically involving an on-board computer and sensors to display several vehicle and/or engine status parameters, should develop rapidly. In conjunction with new display technology, integrated dashboard systems should also grow quickly. While some such devices will be after market add-ons, many will probably be OEM equipment on new truck cabs, particularly top-of-the-line trucks. Limited function systems, i.e., those displaying one or two vehicle/engine functions in addition to conventional instruments, are specific to truck types and operations. It is difficult to estimate the numbers of such devices but those serving unique functions, e.g., refrigerator monitors and axle weight monitors should become prevalent due to relatively low cost and high benefits.

3.2.2 Text Communication Systems

Text Communication Systems appear to be applicable to local vehicles which need frequent information from a local dispatch unit, i.e., pick-up/ delivery vehicles. Text may begin to replace radio communication since it can be stored and retrieved as needed by a driver and provides hard copy records to replace manual recordkeeping.

3.2.3 Vehicle Information Systems

Micro computer based trip recorder type systems which automatically record and display vehicle activity and permit manual input of driver and status information should also see rapid growth in the near future for several reasons.

1) Trade literature citing fleet experiences in using such devices is highly favorable. Benefits of vehicle information system use include, a) improved fuel economy, b) lower maintenance costs, c) improved scheduling, d) less vehicle abuse, e.g., improved driver habits, e) rapid access to vehicle data by management and f) decreased paperwork.

2) Trip Recorder devices appear "reasonably" priced, relative to their benefits. At an initial cost of about $1500 per unit, pay back can occur in just one or two years.

3) There has been rapid growth in new manufacturers entering trip recorder development and marketing. The number of companies involved indicates a potentially large market.

4) It appears that the automatically recorded data log and driver input records could replace manual driver log keeping required by FHWA/OMC. They are now permitted in lieu of manual log keeping. Recorders must be capable of "calling up" data on an in-cab display in order to permit log checks by appropriate authorities.

Vehicle Information Systems are most useful to trucks accruing high mileage, those requiring more maintenance scheduling, and those with high fuel consumption. Also, long distance operation's requiring ICC logs, trucks purchasing fuel on the road, crossing state lines, etc. are prime candidates. Truck types benefiting most from such systems include small and large fleets of high mileage auto transports, tankers, vans and container chassis types. Those which would benefit least are low mileage local trucks such as yard trucks, cranes, services, utility and agricultural vehicles.

3.2.4 Vehicle Tracking/Locating/Navigation

Dead Reckoning as well as satellite based systems permitting a central dispatch to monitor truck position and those systems including in-cab map displays will likely increase in numbers in the near future for several reasons.

1) A number of large well known corporations have entered the development/production field recently, including TRW, Magnavox and Sony indicating a substantial market size.

2) Trade publication articles appear to give such systems high marks for improving fleet efficiency, e.g., maintenance, scheduling, relocating and theft recovery.

3) Costs appear to be on the order of $2000 per unit plus a small monthly fee making investment recovery a short term process.

Larger, local-use trucks making numerous daily pick-ups/deliveries over irregular routes where customer service is crucial are prime candidates for such systems. Vans, public utility, service and walk-in type trucks should see high use, as should police and emergency type vehicles. Trucks operating over regular routes with few stops and low miles, such as tankers, cranes, pole, livestock, dump and garbage trucks, will see lower use.

3.2.5 Vehicle Safety Systems

Video and sonar/radar devices used to supplement rear view mirrors and reduce blind spots in large vehicles have been available for many years. While some have been designed exclusively for vehicle use, others are simply off-the-shelf systems derived from other applications. Video/CRT systems are relatively expensive at $1500-$2000 and their benefits are largely unknown and remain undemonstrated. They appear limited to airport buses and other special purpose vehicles. Very few medium-heavy truck applications have been observed. It is anticipated that proximity sensor/display systems may not become high use devices for truck applications in the near future.

The few medium-heavy truck types which might benefit from proximity devices are those frequently involved in parking and backing into docks, such as delivery vans, a few platform trucks and service/public utility vehicles. All such vehicles must operate in very congested spaces. One company, however, is in the final stages of development of a low cost sonar sensor system to display the "presence" of another vehicle in the blind area to the right front of COE type tractors.

4.0 DEVICE CONTROLS, DISPLAYS AND WORKLOAD ANALYSES

4.1 Controls, Displays and Workload

The in-cab display device inventory exhibits a wide variety of displays ranging from on/off status lamps and two-digit numerics to CRT map images. These imply a range of visual tasks from discreet to continuous. Controls range from single dedicated pushbuttons and knobs to full keyboards. A first step in the analysis of human factors control/display/processing requirements imposed by these devices on users is the identification and description of the device display/control/user interface.

Table 4-1 summarizes the in-cab device inventory:

* identifying the type of displays and controls comprising the user/device interface;

* describing the general information processing requirements imposed on the user and,

* rating the overall operating load (low, medium or high) on the user.

Below the Table are the keys to the display, control and processing abbreviations used earlier in the Table.

* Column 3 identifies the various display types, including analog dial and bar, digital, pictorial, CRT, graphic, text, alphabetic, numeric, audio, status and on-off lamps.

* Column 4 identifies controls including push buttons and pull knobs, full keyboard, numeric, and function only keypads, discrete and continuous rotary controls and touchscreens.

* Column 5 summarizes the general information processing/attention demand requirements imposed on the device user. These include the prior knowledge of system functions or codes, entering and reading text, reading text or numeric output only, and the demand for single, repeat or continuous glances. The final three columns are estimates of load imposed by the system.

Table 4-1 Summary of In-Cab Device Displays, Controls and Processing

FILE NO.	DEVICE	DISPLAYS	CONTROLS	PROCESSING	VISUAL LOAD	MOTOR LOAD	PROC. LOAD
SINGLE/INTEGRATED DISPLAYS							
204	EASY WEIGH	NUM-DIG & STA-LMP	PUSH	NUM OUT/GLANCE	L	L	L
211	CHARLIE	STA-LMP	PUSH	GLANCE	L	L	L
225	FUEL TACH	NUM-DIG & ANL-DIAL	NONE	NUM OUT/GLANCE	L	NONE	L
244	CARGO SAVER II	NUM-DIG & AUDIO & STA-LMP	?	NUM OUT/GLANCE	M	?	L
251A	MODE PRO IV	NUM-DIG & STA-LMP	PUSH & CONT-ROT	NUM OUT/GLANCE	L	M	L
251B	MODE PRO V	NUM-DIG & STA-LMP	PUSH	TEXT OUT/GLANCE	M	L	M
253	DB212 DIGITAL/BAROGRAPH	NUM-DIG & ANL-BAR	PUSH	NUM OUT/GLANCE	M	L	L-M
255	ETEC II	NONE	NONE	NONE	NONE	NONE	NONE
258	DIGITAL TEMP. CONTROL SYS.	NUM-DIG & STA-LMP	FUNCT KEY	TEXT OUT/FUNCT	M	M	M
260	ARGO EDM	NUM-DIG & ANL-DIAL	PUSH	NUM OUT/GLANCE	L-M	L	L
261	T MACS	NUM-DIG	NONE IN CAB	NUM OUT/GLANCE	L	NONE	L
216	ELECTRONIC DASH	NUM-DIG & ANL-DIAL &ANL-BAR	ASSUME PUSH	NUM OUT/REPEAT/FUNCT	L-M	L-M	L-M
226B	AUDIT	CRT-TXT	PUSH	NUM OUT/REPEAT/FUNCT	M-H	M	L-M
227	ELECTRONIC DASHBOARD	NUM-DIG & ANL-BAR & ANL-DIAL	ASSUME PUSH	NUM OUT/REPEAT/FUNCT	L-M	L-M	L-M
243	DDEC II	ALP/NUM-DIG	?	TEXT OUT/GLANCE	L-M	?	M
248	VIP	AUDIO & STA-LMP	NONE	GLANCE	L	NONE	L
TEXT COMMUNICATIONS SYSTEMS							
262	MDI 7031	ALPH/NUM-DIG & STA-LMP	PUSH & NUM KEY	TEXT OUT/FUNCT	M	M	M
263	MDI 9031	CRT-TXT	FULL-KEY & CONT-ROT	TEXT I-O/FUNCT	H	H	H

Table 4-1 Summary of In-Cab Device Displays, Controls and Processing

FILE NO.	DEVICE	DISPLAYS	CONTROLS	PROCESSING	VISUAL LOAD	MOTOR LOAD	PROC. LOAD
VEHICLE INFORMATION SYSTEMS							
207A	FMSS 1330 (BASIC)	NUM-DIG	PUSH & DISC-ROT	HIGH FUNCT	M	M	M
207B	FMSS 1330 (OPTIONAL)	ALP/NUM-DIG	NUM/FUNCT KEY	NUM OUT/FUNCT	M	M	M
208A	CADEC 100	STA-LMP	NONE	GLANCE	L	NONE	L
208B	CADEC 200 & 300	ALP/NUM-DIG	PUSH & NUM-KEY	TEXT OUT/FUNCT	M	M	M
209	FLEET DATA MASTER	ALP/NUM-DIG	NUM/FUNCT-KEY	TEXT OUT/FUNCT	M	M	M
213	UNIPARS	ALP/NUM-DIG	?	FUNCT	M	?	M
214	SILENT 1000	ALP/NUM-DIG	PUSH	NUM OUT/LOW FUNCT	M	L	M
217A	TRIPMSTR (w KEY INPUT)	NONE	INSERT I.D. CARD	NONE	NONE	L	NONE
217B	TRIPMSTR (w DRIVER INPUT)	NUM-DIG	PUSH & DISC-ROT	FUNCT	M	M	M
217C	TRIPMSTR (w DRIVER KEY)	ALP/NUM-DIG	NUM/FXN-KEY	TEXT OUT/FUNCT	M	M	M
220	DATA-COM	ALP/NUM-DIG	NUM OR FUNCT-KEY	NUM OUT/FUNCT	M	M	M
222	SYSTEM 7000	ALP/NUM-DIG	NUM/FXN-KEY	TEXT I-O/FUNCT	M	M	M
240	DRIVER INFORMATION SYS.	CRT-TXT	TOUCH SCREEN	FUNCT	H	M	M
242	TC-1	ALP/NUM-DIG	FUNCT-KEY	NUM OUT/FUNCT	M	M	M
249	ELECTRONIC RECORDER	NONE	NONE	NONE	NONE	NONE	NONE
263	MILOG	ALP/NUM-DIG	FUNCT-KEY	TEXT I-O/FUNCT	M	M	M
264	AL100	ALP/NUM-DIG	NUM-KEY	TEXT OUT/FUNCT	M	M	M
VEHICLE NAVIGATION SYSTEMS							
228	TRUCK TRACKER	CRT-TXT/GRAPH	?		?	?	M-H
246	NAV-COM	CRT-TXT/GRAPH	?	CONT RECOG	?	?	M-H
254	OMNITRACS	CRT-TXT/GRAPH	?	TEXT OUT	?	?	?
270	ETAK NAVIGATOR	CRT-TXT/GRAPH	?	TEXT I-O/CONT/FUNCT	H	?	M-H
VEHICLE TRACKING SYSTEMS							
203	RDSS	ALPH/NUM-DIG	FULL-KEY	TEXT I-O/CONT/FUNCT	M	H	H
236	II MORROW VTS	STA-LMP	PUSH/ DISCR-ROT	REPEAT GLANCE/FUNCT	L	M	M
256	ROCKWELL POSITIONING SYS.	?	?	?	?	?	?

Table 4-1 Summary of In-Cab Device Displays, Controls and Processing

FILE NO.	DEVICE	DISPLAYS	CONTROLS	PROCESSING	VISUAL LOAD	MOTOR LOAD	PROC. LOAD
VEHICLE SAFETY SYSTEMS							
205	CAR VISION SYSTEM 9300	CRT-PICT & STA-LMP	PUSH & CONT-ROT	CONT RECOG	M	L	L-H
226A	MODEL 750	CRT-PICT & STA-LMP	PUSH	CONT RECOG	M	L	L-H
231	AUTOMOTIVE WATCHCAM	CRT-PICT & AUDIO	NONE	CONT RECOG	M	NONE	L-H
238	CARDAR	AUDIO & ANL-BAR?	?		?	?	?
241	RETRO-GUARD	AUDIO & NUM-DIG	NONE	REPEAT GLANCE	L	NONE	L
245	TATTLE TALE	AUDIO & STA-LMP & ANL-BAR	NONE	REPEAT GLANCE	M	NONE	M
247A	EBS 1013	ANL-BAR	NONE	REPEAT GLANCE	L	NONE	L
247B	EBS 3060	AUDIO & STA-LMP	NONE	GLANCE	L	NONE	L
265	BACK SENSOR	AUDIO & ANL-DIAL	PULL & CONT-ROT	REPEAT GLANCE	L	L	L
229	EAGLE EYE	AUDIO & STA-LMP	NONE	GLANCE	L	NONE	L

KEY TO ABREVIATIONS USED

DISPLAYS	CONTROLS	PROCESSING
ANALOG (ANL)	PUSHBUTTON (PUSH)	KNOW FUNCT. OR CODES (FUNCT)
DIGITAL (DIG)	PULL ACTIVATION (PULL)	TEXT INPUT & OUTPUT (TEXT IN-OUT)
PICTORAL (PICT)	FULL KEYBOARD (KEY)	TEXT OUTPUT ONLY (TEXT OUT)
GRAPHIC (GRAPH)	NUMERIC KEYPAD (NUM KEY)	NUMERIC OUTPUT ONLY (NUM OUT)
TEXT (TXT)	FUNCTION KEYPAD (FUNCT KEY)	OCCASIONAL UPDATE (GLANCE)
ALPHABETIC (ALPH)	CONTIN. ROTARY (CONT ROT)	FREQUENT UPDATE (REP GLANCE)
NUMERIC (NUM)	DISCRETE ROTARY (DISC ROT)	CONTINUOUS UPDATE (CONT RECOG)
CRT (CRT)	TOUCH SCREEN (TCH SCR)	
AUDIO (AUDIO)		
STATUS (STA)		
LAMP (LMP)		

Visual load estimates are based on the display types and extent of user interaction required. A visual load rating of low (L), medium (M), or high (H) was assigned to each device. A low visual load rating was typically applied for status lamp checks, reading of a few digits, or detecting an audio alarm, for example. A medium rating was applied when short amounts of text are read or in cases where visual scenes are viewed briefly on a CRT. A high (H) rating was reserved for displays in which large amounts of text are presented or complex pictorial displays are viewed. Since visual load of some systems varied depending on the functions available, a rating of low to medium (L-M) was occasionally necessary.

Similarly, based on the types of controls and the extent of interaction with these controls, a motor load rating was assigned. A low motor load rating was applied for pushbutton use, for example, as to turn on a device or make a simple function selection. A medium rating was given for devices which include numeric or function keypad use or when a combination of rotary and pushbuttons are combined to enter information. Finally, a high load rating is reserved for devices which include full use of an alpha numeric keyboard.

Finally, a processing load rating was applied. A low (L) rating indicates that a minimum amount of mental capacity was judged to be necessary, typically those cases where only a few digits are to be read by a quick glance. A medium (M) rating indicates some knowledge of device functions may be necessary, where repeated glances are needed with attention allocated at each glance, or where short text must be comprehended. A high rating is reserved for cases in which large amounts of text must be comprehended, processed, and responses entered into the device. A high rating was also typically applied when continuous attention and recognition are required.

4.2 Display Device Interface Summary

4.2.1 Single/Integrated Displays

Devices included in this category are typically single, simple displays or groups of displays dedicated to single functions. Most common are refrigeration monitors indicating temperature and status. Device displays consist mostly of limited digit (< 4) quantitative readings, discreet status

lamps and, to some extent, analog bar or dial displays. Controls also tend to be simple, involving discreet pushbutton operation for selection. Driver information processing is fairly simple, involving status checks and simple quantitative readings. If properly designed and human engineered, they should pose no more of a safety problem than conventional instrumentation when used during driving.

4.2.2 Text Communication Systems

Text Communication Systems, on the other hand, are quite complex in terms of visual load, control interface and, potentially information processing. Displays require reading and understanding of alpha numeric text material, while controls are typically full keyboards with function select pushbuttons. Extended messages can be entered. Information processing, i.e., reading and understanding text messages, is also relatively complex, potentially involving a heavy visual and mental load and focus of attention. Conceivably, demands on a driver/user could approach those of reading and typing tasks required of a dispatcher who is not already loaded with a driving task.

4.2.3 Vehicle Information Systems

Vehicle Information Systems are typically on-board computers which sense, record and display vehicle information and many permit driver entry of additional information, ranging from simple codes to alpha numeric text type data. Some systems include on-board paper tape printers.

Controls, displays and information processing range from fairly simple to quite complex. One device may simply display system status while another may require entry of up to 99 codes (memorized by the driver?) using a cumbersome pushbutton entry method often requiring use of preformatted menus. Others permit selecting and viewing of vehicle statistics, such as average trip speed, and some permit hard copy printing of vehicle data.

While most systems record information to be used primarily for off-site management reports, most do not (according to literature) preclude in-cab display of such information. Also, many require complex data entry quite

incompatible with the driving task. Section 4.4 describes a sample data-entry task for one trip recorder type system.

4.2.4 Vehicle Navigation Systems

Most Vehicle Navigation Systems are in the development, test or demonstration stage so that little detail regarding driver interface is available. The ETAK Navigator, discussed in section 4.5, is an exception. Conceptually, these systems involve an in-cab map CRT display showing roadways, key landmarks, driver location and selected destination. In addition, they may plot optimum route and integrate traffic information for the user. The user's task is similar to that of reading a map. Since the primary benefits of navigation systems are obtained during driving, that is, real time navigation rather than pre-trip planning and route selection, they will undoubtedly be used during driving. Following specific human factors design features is essential to ensuring safe use of such systems.

4.2.5 Vehicle Tracking Systems

Vehicle Tracking Systems typically permit a second party, such as a central dispatch center, to track the position of a fleet of trucks and to display truck locations on a map display. In order to re-route vehicles, two way communication may be provided. Devices are comprised of fairly simple displays but have a high load for data entry, e.g., load, ETA, miles remaining. Some systems require interface with a full typewriter-type keyboard. The selection of functions and text entry imposes a heavy processing load since relatively complex text data may be entered.

4.2.6 Vehicle Safety Systems

This category of devices is comprised of video and other electronic sensor/display technologies for providing the drivers' of vehicles having rear blind areas supplemental information regarding objects in sensor range typically during backing. A few, however, are offered by manufacturers as usable for "seeing" along side of a vehicle into blind areas during turning or lane changing. Future concepts suggest possible replacement of rear-view mirrors by closed circuit television but cost may preclude widespread use.

Since drivers are typically backing during use, and may often be off the roadway, the primary task of forward viewing is less relevant, except for side viewing system applications. In order to preclude viewing while driving forward, some systems are only engaged automatically during backing. Most do not have such a feature. At least one video backing system has modified electronics which preclude video playback and broadcast reception.

4.3 Device Use and Truck Activity

When a display device needs to be used or is likely to be used by a driver, truck activity is a crucial factor in determining device/safety compatibility. If a device is used only when a truck is parked or stopped, there is obviously no direct impact on driving safety and its operability or design features are not safety relevant. On the other hand, some devices have utility to a driver only when the vehicle is moving forward. These include engine functions, warnings, maps and traffic up-dates. Other devices are useful only when the vehicle is backing, such as video and electronic safety systems.

A preliminary analysis was conducted to illustrate which in-cab display devices are likely to be used during specific kinds of truck activity. Table 4-2 indicates, for each device inventoried, whether it is likely to be used when a truck is moving forward or backward or is parked or stopped. Since some display devices have more than one mode of operation or involve several possible functions, differing in complexity (e.g., vehicle information systems involve simple function select and display viewing, as well as complex menu-following and text entry), estimates of truck activity for simple and complex display and control functions are shown where applicable. It should be noted that limited available specifications precluded determination of task complexity or truck activity for some devices.

4.4 Sample Trip Recorder Task Description

To illustrate the excessive task demand inherent in the use of some in-cab display device functions, a simple task description/analysis was done for one vehicle information system function. The function described is that of a driver entering his location and gross vehicle weight into a trip recorder.

Table 4-2 Probable Truck Activity During Device Use

IN-CAB DEVICE	DEVICE DISPLAY DEMANDS		DEVICE CONTROL DEMANDS	
	LOW	HIGH	LOW	HIGH
SINGLE/INTEGRATED DISPLAYS				
EASY WEIGH	PKD	N/A	PKD	N/A
CHARLIE	FWD	N/A	FWD	N/A
FUEL TACH	FWD	N/A	N/A	N/A
CARGO SAVER II	FWD	N/A	PKD	N/A
MODE PRO IV	FWD	N/A	FWD	N/A
MODE PRO V	FWD	N/A	FWD	N/A
DB212 DIGITAL/BAROGRAPH	FWD	N/A	FWD	N/A
ETEC II	N/A	N/A	N/A	N/A
DIGITAL TEMP. CONTROL SYS.				
ARGO EDM	FWD	N/A	FWD	N/A
T MACS	FWD	N/A		N/A
ELECTRONIC DASH	FWD	N/A	FWD	N/A
AUDIT	?	?	?	?
ELECTRONIC DASHBOARD	?	?	?	?
DDEC II	FWD	N/A	FWD	N/A
VIP	FWD	N/A	N/A	N/A
TEXT COMMUNICATION SYSTEMS				
MDI 7031	N/A	FWD	STP	N/A
MDI 9031	FWD	FWD	FWD	STP
VEHICLE INFORMATION SYSTEMS				
FMSS 1330 (BASIC)	N/A	STP	STP	STP
FMSS 1330 (OPTIONAL)	N/A	STP	STP	STP
CADEC 100	FWD	N/A	N/A	N/A
CADEC 200 & 300	FWD	STP	FWD	STP
FLEET DATA MASTER	FWD	N/A	FWD	STP
UNIPARS	STP	N/A	STP	N/A
SILENT 1000	FWD	STP	FWD	STP
TRIPMSTR (w KEY INPUT)	N/A	N/A	N/A	N/A
TRIPMSTR (w DRIVER INPUT)	N/A	STP	STP	STP
TRIPMSTR (w DRIVER KEY)	FWD	STP	FWD	STP
DATA-COM	?	?	?	?
SYSTEM 7000	FWD	STP	FWD	STP
DRIVER INFORMATION SYS.	FWD	FWD	FWD	STP
TC-1	FWD	STP	FWD	STP
ELECTRONIC RECORDER	N/A	N/A	N/A	N/A
MILOG	N/A	STP	N/A	STP
AL100	N/A	STP	N/A	STP

Table 4-2 Probable Truck Activity During Device Use

IN-CAB DEVICE	DEVICE DISPLAY DEMANDS		DEVICE CONTROL DEMANDS	
	LOW	HIGH	LOW	HIGH
NAVIGATION SYSTEMS				
TRUCK TRACKER	?	FWD	?	FWD
NAV-COM	?	FWD	?	FWD
OMNITRACS	?	FWD	?	FWD
ETAK NAVIGATOR	?	FWD	FWD	FWD
TRACKING SYSTEMS				
RDSS	N/A	STP	N/A	STP
II MORROW VTS	N/A	STP	N/A	STP
ROCKWELL POSITIONING SYS.	?	STP	?	STP
VEHICLE SAFETY SYSTEMS				
CAR VISION SYSTEM 9300	STP	BCK	STP	N/A
MODEL 750	STP	BCK	STP	N/A
AUTOMOTIVE WATCHCAM	?	BCK/FWD?	?	N/A
CARDAR	?	BCK	?	N/A
RETRO-GUARD	STP	N/A	STP	N/A
TATTLE TALE	STP	N/A	?	?
EBS 1013	STP	N/A	STP	N/A
EBS 3060	STP	N/A	STP	N/A
BACK SENSOR	STP	N/A	STP	N/A
EAGLE EYE	STP	N/A	?	N/A

KEY TO ABREVIATIONS

FWD = MOVING FORWARD ON ROAD
STP = STOPPED ON /OFF ROAD
PKD = PARKED
BCK = BACKING
N/A = CONTROL/DISPLAY NOT AVAILABLE

The scenario postulated is that the driver has just left a weigh station on California Highway 9 and has forgotten to enter the vehicle weight, which his employer requires that he do, into his onboard vehicle information system. The driver's task involves entering C-A-9 (location) and 1-1-2-5 (weight), using the hand held calculator-size two line display and 24 pushbutton keyboard shown in Figure 4-1.

The information displayed on the two line LCD and the various decisions, function select and data entry pushbutton presses are illustrated in Figure 4-2. As shown, twenty-two key presses are required to enter CA9 and vehicle weight of 1125. Each entry requires diversion of vision and attention from the primary task to view the keyboard and adjacent display if the "manual" function is originally selected. If the "scroll" function is selected, the key must be depressed and the display viewed as the system scrolls to the thirteenth function--"scale record."

In the judgement of the authors, performance of the foregoing task is not compatible with safe driving under most, if not all conditions. While the "mental" load does not appear high, the large number of key entries and entry verification on the display are likely to "capture" the attention of a driver. Second, the sequence of entries is extraordinary lengthy due to the absence of a human engineered keypad as exemplified by the need to press the "1" key three times to enter a "C."

4.5 Driving Quality And In-Cab Task Looking Behavior

A recent study sponsored by General Motors Corporation conducted by Antin, et. al. (1986) provides data permitting analysis of the relation between driving quality and task imposed looking behavior. Data from that study, in which driver looking behavior and driving quality were measured during the performance of 27 control/display tasks, including those of the ETAK Navigator, while driving a 1985 Cadillac on a standard road, were re-analyzed. The purpose was to determine 1) if tasks grouped on the basis of driver actions required were related to driving performance quality and 2) the relation between driver task performance measures and driving quality measures.

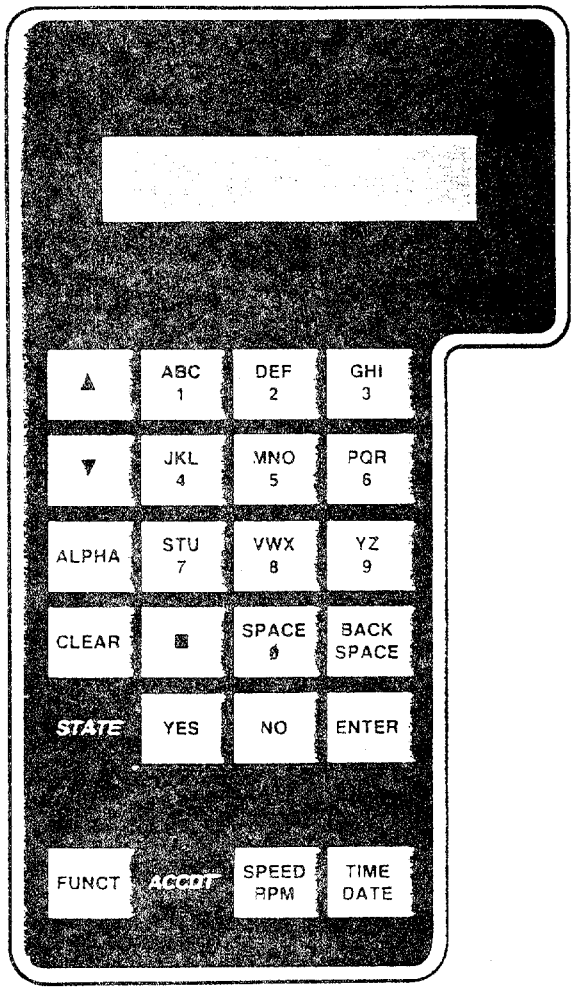


Figure 4-1 Data Entry / Display Device

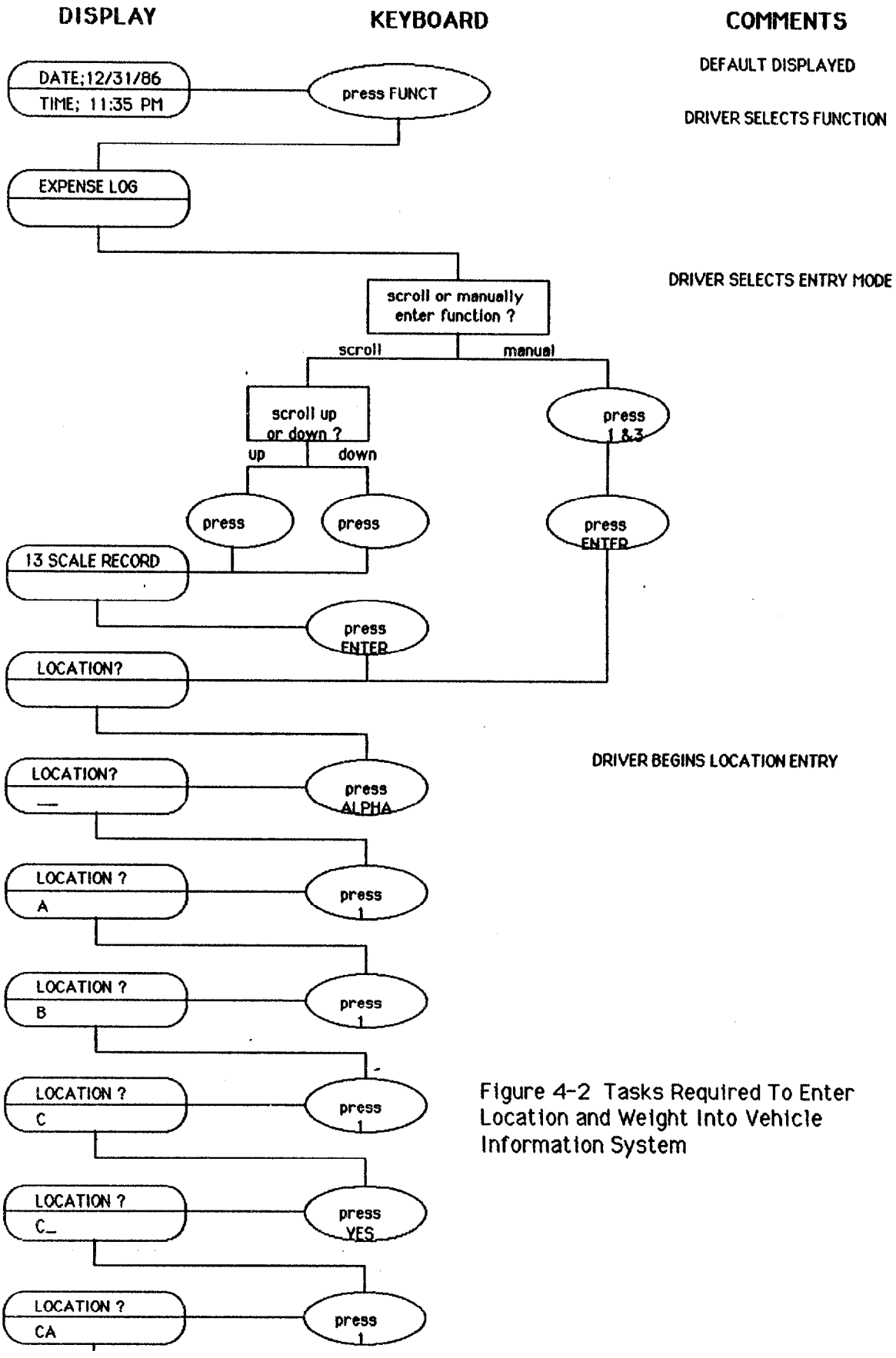
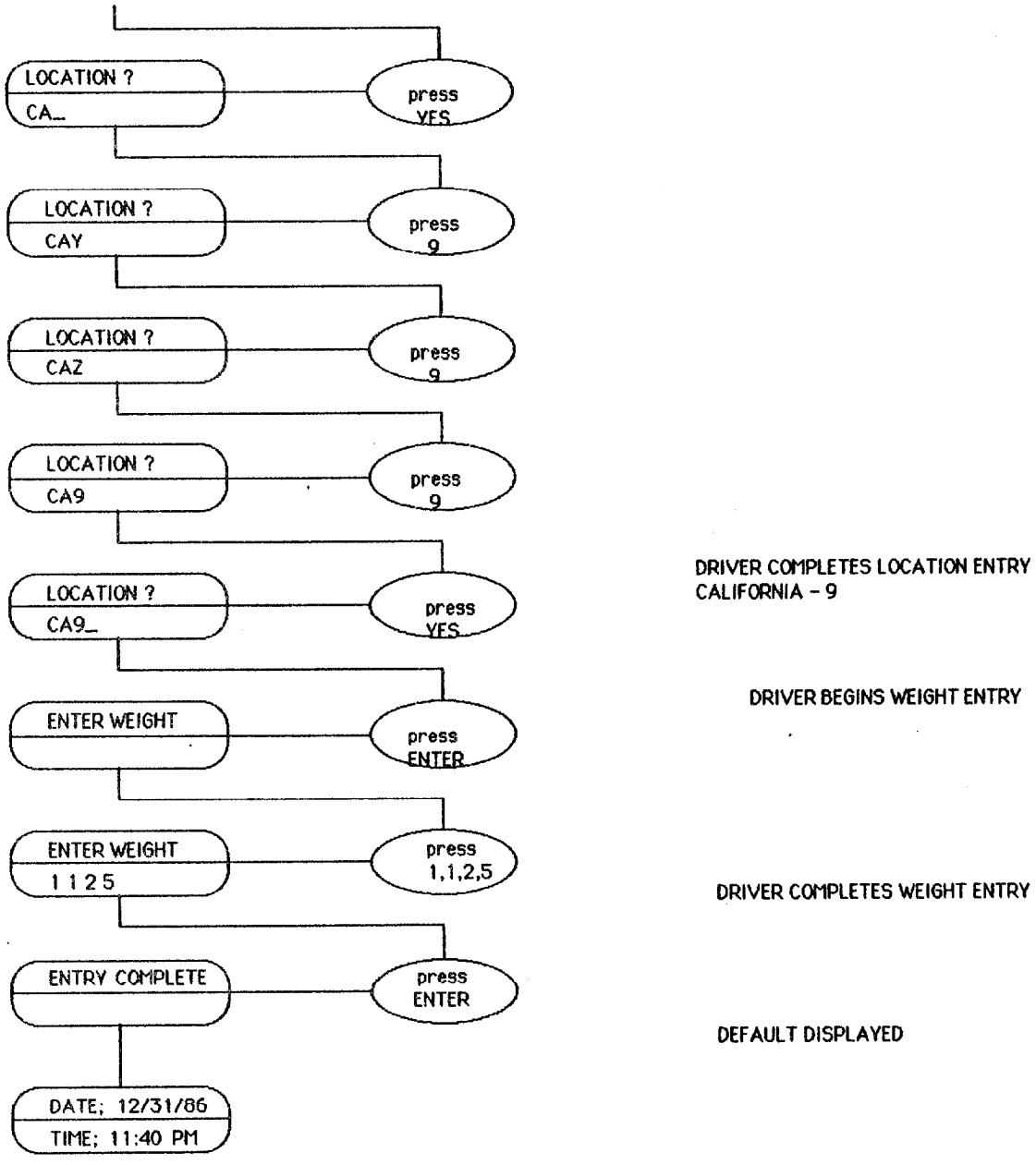


Figure 4-2 Tasks Required To Enter Location and Weight Into Vehicle Information System



KEY TO SYMBOLS

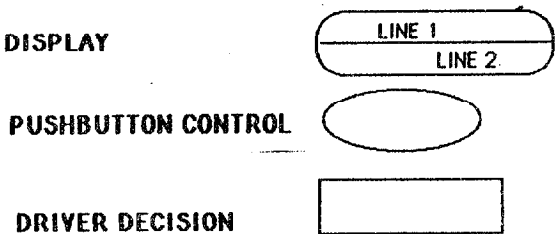


Figure 4-2 Tasks Required To Enter Location and Weight Into Vehicle Information System

4.5.1 Relation Between Task Type and Driving Quality

Frequency and duration of lane line crossings were measured during performance of each task. Lane line crossing involves exceeding the lane markings and entering into another vehicle's lane of travel. Lane line crossing is generally accepted as a measure of driving quality in that a driver is not properly controlling vehicle direction which can lead to conflicts/collisions with vehicles in other traffic lanes. The 26 tasks included checks of speed, radio tuning and temperature adjustment. The percent of trials on which a lane line was crossed ranged from zero for speedometer checks and 3.1 percent for defrost setting to almost 22 percent for the task of tuning the radio on the Cadillac.

Glance time, i.e., the length of time spent looking at a display/control per look and glance frequency, i.e., the number of looks at a display or control were the basic measures of drivers performance while performing each of twenty-six in-vehicle tasks. These measures were used to calculate glance time and frequency variability--a measure of the range or spread of measures--as well as total looking time to complete the task. These data were factor analyzed by the authors in an attempt to "group" similar tasks and possibly identify distinct task types. Factor loadings and task descriptions were analyzed and five task types identified. Table 4-3 identifies the types and specific tasks included in each along with user activities, glance frequency, duration and lane line crossing percentages. Task Type I is comprised of one unique task -- turn signal activation-- which required less than one look per task. Task Type II is comprised of those requiring simple digital display reading, e.g., speedometer check. Type III typically involves single button presses or single short control adjustments and/or reading a digital display, e.g., push button/read digital display. Type IV involves more complex activities such as short continuous control adjustments, multiple button presses and user judgements based upon displayed data. Finally, Type V appears to involve complex and ongoing, long duration control adjustments, multiple button presses and numerous ongoing judgements by the user.

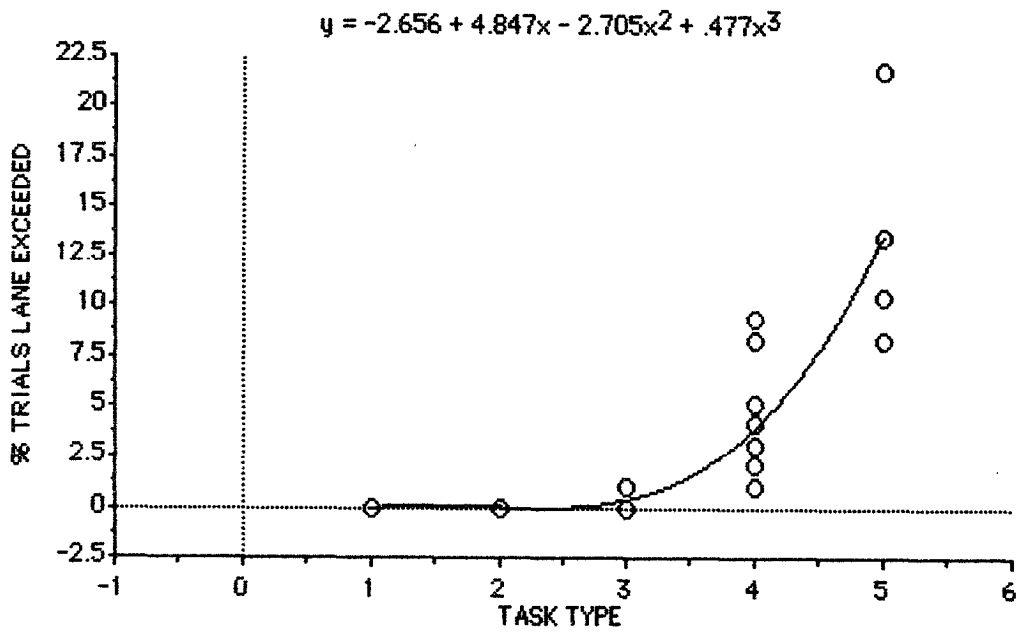
The percent of trials in which lane lines were crossed is shown in Figure 4-3 for each of the five task types identified above. No lane line

Table 4-3. Summary of Tasks and Performance Measures Used For ETAK Evaluation

TASK TYPE	DISPLAY/CONTROL TASK	USER ACTIVITIES	GLANCE FREQ.	GLANCE DURATION (SEC)	% LINE CROSSINGS
I	ACTIVATE TURN SIGNAL	PRESS	0.63	0.30	0.00
		AVERAGE	**0.63**	**0.30**	**0.00**
II	CHECK SPEEDOMETER	READ DIGITAL	1.26	0.62	0.00
	CHECK FOLLOWING TRAFFIC	VIEW MIRROR	1.31	0.75	0.00
	CHECK TIME	READ DIGITAL	1.26	0.83	0.00
	CHECK DEST. DIRECTION*	READ DIGITAL CRT	1.31	1.20	0.00
	CHECK REMAINING FUEL	READ DIGITAL	1.52	1.04	0.00
		AVERAGE	**1.33**	**0.89**	**0.00**
III	ADJUST AIR VENT	ADJUST	1.83	0.62	0.00
	CHECK DEST. DISTANCE*	READ DIGITAL CRT	1.73	1.06	0.00
	TURN ON FAN	PRESS BUTTON	1.78	1.10	1.04
		AVERAGE	**1.78**	**0.93**	**0.35**
IV	CHECK INFO. STATUS LTS.	CHECK TWO SETS	2.12	0.83	3.13
	ADJUST RADIO BALANCE	CONT. ADJUSTMENT	2.58	0.86	2.08
	ADJUST RADIO TONE	CONT. ADJUSTMENT	1.73	0.92	1.04
	ADJUST LIGHT SENTINAL	ADJUST	2.51	1.01	2.08
	TURN ON DEFROST	PRESS-PRESS	2.51	1.14	3.13
	CHECK FUEL ECONOMY	PRESS-READ DIGITAL	2.88	1.14	3.13
	CHECK HEADING*	READ CRT-JUDGEMENT	2.76	1.30	3.13
	CHECK ZOOM LEVEL*	READ CRT-JUDGEMENT	2.91	1.40	4.17
	CHECK CORRECT DIRECTION*	READ CRT-JUDGEMENT	2.04	1.45	1.04
	CHECK ROADWAY DIST.*	READ CRT-JUDGEMENT	5.78	1.53	9.38
	CHECK ROADWAY NAME*	READ CRT-JUDGE/REPEAT	6.52	1.63	8.33
	CHECK CROSS STREET*	READ CRT-JUDGE/REPEAT	5.21	1.66	8.33
		AVERAGE	**3.30**	**1.24**	**4.08**
V	PLAY CASSETTE	FIND-ORIENT-INSRT-PRESS	2.06	0.80	13.50
	ADJUST POWER MIRROR	PRESS-CONT. ADJUSTMENT	6.64	0.86	21.88
	ADJUST TEMP.	CONT. ADJUSTMENT	3.18	1.10	8.33
	CHECK FUEL RANGE	PRESS-READ DIGITAL	2.51	1.19	5.21
	TUNE RADIO	CONT. ADJUSTMENT	6.91	1.10	10.44
		AVERAGE	**4.26**	**1.01**	**11.87**

* ETAK TASKS, ALL OTHERS ARE 1985 CADILLAC SEVILLE TASKS

Figure 4-3 Relation Between Task Type and Line Crossings



crossings were observed for the simplest Type I and II tasks while such crossings were observed in 7-20 percent of the trials involving Type V task performance. Clearly, the more complex the task, the greater the lane line crossing frequency, i.e., the lower driving quality or safety.

4.5.2 The Relation Between Driving Quality and Task Imposed Looking Requirements

Correlations among the various glance and performance time measures and lane line crossings provided in that study were calculated and analyzed further. Results indicate that glance time measures correlate positively with one another but that average glance time is not significantly related to lane line crossing frequency as shown in Figure 4-4. Average glance time tended to be short, however, ranging from .62 to 1.66 seconds. On the other hand, average glance frequency per task and glance frequency variability (1 std. dev.) were highly correlated with lane line crossings, i.e., driving quality (r=.784 and .688 respectively). R squared, a measure of the association, is .616 indicating that 61.6 percent of the variability in driving quality is accounted for by the single predictor glance frequency per task. The relation between average glance frequency per task and line crossings is shown in Figure 4-5. It appears, then, that at least for the sample of 26 in-vehicle tasks considered by Antin, et al., that task imposed glance frequency is an excellent predictor of driving quality and thus of safety. This relation should be further explored as a potential design guideline and/or criterion for in-cab device design and evaluation.

Figure 4-4 Relation Between Average Glance Time and Lane Crossings

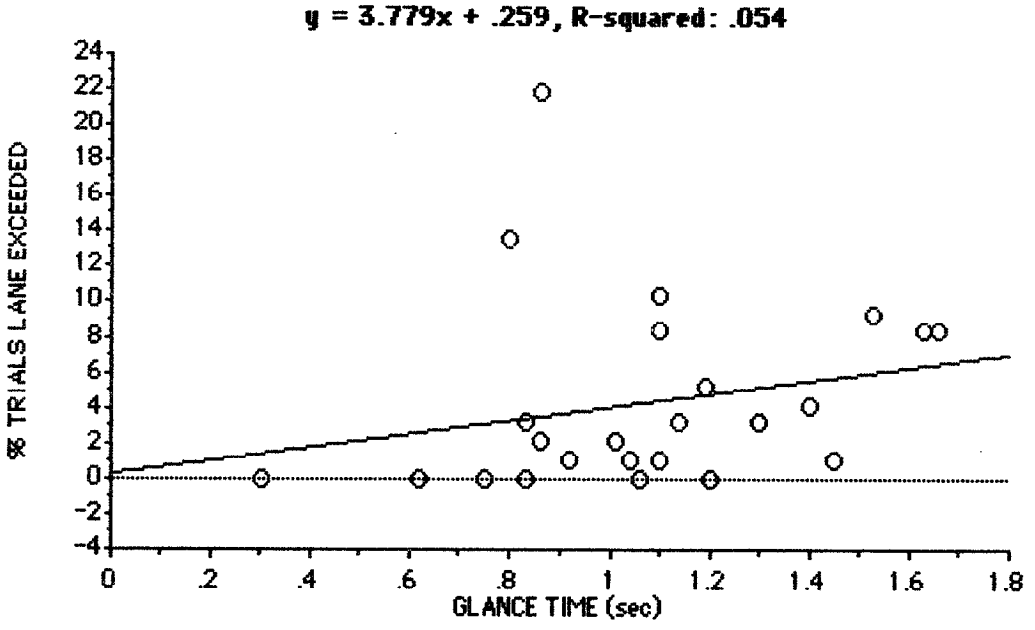
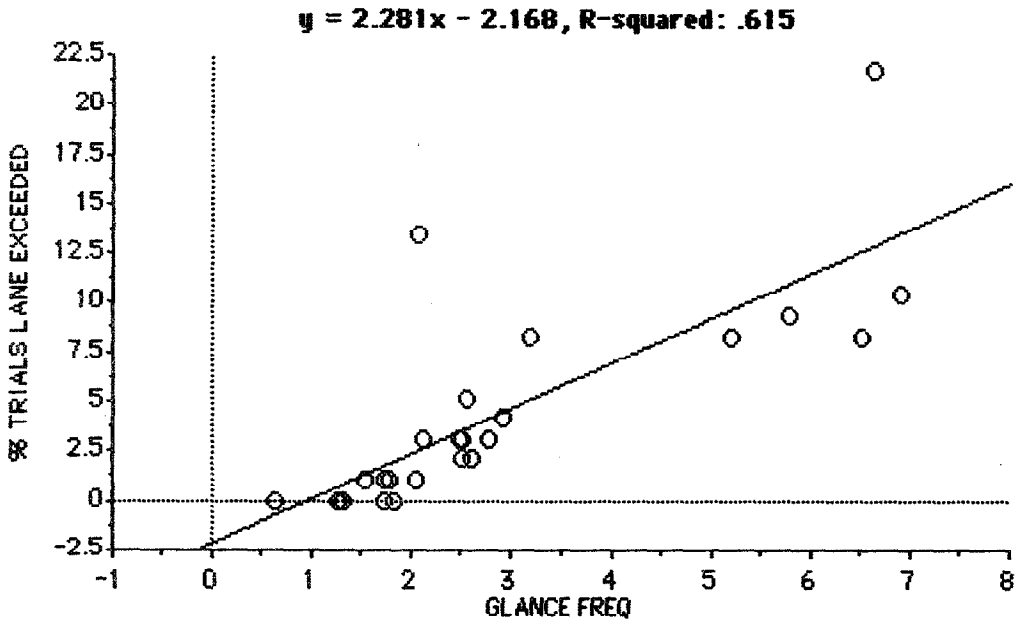


Figure 4-5 Relation Between Average Glance Frequency and Lane Crossings



5.0 IN-CAB DEVICE EVALUATION STRATAGIES

5.1 INTRODUCTION

It is highly likely that some of the in-cab devices described earlier could, if used during driving, decrease primary visual/attention by increasing driver work load and result ultimately in increased truck crashes. On the other hand, some devices appear to require no more driver interaction than conventional truck instrumentation and no significant performance degradation is anticipated. All in-cab devices identified generally provide useful information to a driver and/or to fleet management, for the purpose of enhancing operating efficiency and providing cost-saving benefits to the user. The problem is to distinguish those devices which can be safely used during driving from those which cannot.

There are many potential approaches to such test and evaluation. Each differs with respect to development and operating costs, face validity, data reliability, development lead time and the ultimate acceptance of conclusions by various interested parties, including manufacturers, users and regulators. The pursuit and ultimate success or failure of one or more of these approaches is highly dependent upon the objectives or goals of an evaluation program. Therefore, prior to the subsequent discussion of alternative device evaluation approaches, several distinct objectives are briefly considered. A decision regarding which objectives are ultimately to be met obviously must be made prior to selection of any approach. The pursuit of an approach not directly tied to objectives would not lead to a satisfactory problem solution. As a first step, then, the U.S. Department of Transportation and/or agencies therein, must clearly establish these objectives.

5.2 OBJECTIVES

There are several possible objectives, each related to the general goal of evaluating the use of in-cab devices during driving in terms of their potential negative impact on safety of vehicle operation. Objectives may be complementary, rather than incompatible. Three primary objectives are briefly discussed below.

5.2.1 Enhance Understanding of Driver/Vehicle Interface

One basic objective is to conduct basic research relevant to the broad issue of driving safety and control/display/processing demands and requirements. Such an objective would serve to provide a framework or driver performance data base which could feed into Government regulatory or industry self regulation objectives and be applicable to OEM and aftermarket devices as well. In addition, this data base would be applicable to other vehicles, including passenger vehicles which, while not of direct interest in this study, will no doubt encounter the same information display overload concerns in the near future as more electronic displays are introduced in them.

Presently, very little is known regarding the broad questions of current driver load and spare capacity. While there is agreement in the belief that drivers are sometimes heavily loaded, that load has not been adequately quantified and, as a result, we have virtually no idea of how much it can be increased without degrading primary performance and safety.

Consideration should be given to conducting fundamental research on the driver-vehicle display/control interface and task demands to provide basic information regarding which behavioral tasks are and are not compatible with driving and how those tasks should be configured. As more and more device demands (e.g., maps, telephones, keyboards) are added to the current demand, the problems will continue to grow if design guidelines remain absent. The Swedish motor vehicle manufacturers are beginning to sponsor significant research related to safety aspects of vehicle electronics and the Dutch have conducted some research on navigation systems for automobiles Other foreign agencies may do likewise in the near future, due to the apparent safety impacts.

5.2.2 Provide Industry Guidelines

Another objective might involve a cooperative effort with the various involved trucking associations, SAE, users and manufacturers of aftermarket and OEM equipment in order to make those groups aware of potential safety problems and to provide guidelines and research data which could ultimately result in industry self-regulation. Human factors and ergonomic guidelines

would aid in the design of equipment compatible with driver capabilities and limitations. Additional performance guidelines could help establish which generic device functions (map reading, menu following, text entry, etc.) can and cannot be safely performed during the primary driving task. Past experience regarding such government/industry associations should be helpful in determining the potential effectiveness of this objective with respect to in-cab displays.

5.2.3 Establish and Enforce Performance Standards

One Governmental objective might be the establishment and enforcement of standards regarding the performance of in-cab display devices--much the same as is currently in effect with respect to rear view mirrors and vehicle controls. This objective, however, is much more complex than regulation of a headlamp since complex functions are at issue rather than relatively simple hardware. Relevant device operational characteristics, e.g., number and length of looks required to operate a device or devices or acceptable increased attention demand to operate them, for example, could be identified, and performance measures and standards established. Alternatively, a standard of overall driver performance on primary driving task components, e.g., lane tracking, lead vehicle brake light detection probability or response time to hazards, could be established and the impact of using one or more of these devices could be gauged against that standard. Section 4.5 summarizes recent research data illustrating the possible development of driving quality measures as criterion. Following evaluation tests, devices would be accepted or rejected for use during driving based upon these performance measures and criteria.

The selection of one or more of these objectives, that is, to:

* develop industry/government design guidelines;

* establish and enforce performance standards, or

* establish a broad driver/vehicle interface research program to support either or both of the above,

is essential to subsequent selection of an evaluation approach which will meet desired objectives.

5.3 EVALUATION PERFORMANCE MEASURES AND CRITERION

5.3.1 General Considerations

In addition to a clear statement of in-cab device evaluation objectives, issues pertinent to evaluation performance measurement and performance criteria must be clearly understood. The specific performance variable(s) selected for measurement in any evaluation, in addition to having considerable cost implications, perhaps more importantly dictates the generality and acceptance of results by interested parties. A "weak" or invalid performance measure is likely to generate measures which are suspect and perhaps not acceptable to anyone. The most valid performance measures, on the other hand, while widely accepted, may be too difficult to obtain because of practical, safety or cost constraints. Selection of a performance criterion is generally difficult, but it is essential.

5.3.2 Primary Performance Measures

Accident data are currently popular in the U.S. as the most acceptable performance measure for evaluation of devices designed to improve motor vehicle safety. Unfortunately, it is unlikely that such a measure could be employed. An insufficient number of devices are expected to be available and lack of controlled observation would preclude statistical post hoc comparisons of accident data. On the other hand, the accident experience of user-fleets could be of considerable interest in identifying problems and suggesting solutions.

5.3.3 Surrogate Performance Measures

Given the practical inappropriateness of the primary performance measure, crash rate, surrogate measures are the only alternatives. Surrogate measures are those which have been or can be related either empirically or logically (preferably the former) to accident involvement. Two levels of surrogate measures can be defined.

The first level is comprised of operator-vehicle system performance measures which have at least a fairly clear logical relation to the primary measure of accident involvement. A partial listing of those commonly used in motor vehicle studies include:

* lane tracking (eg., line crossing frequency, magnitude and duration);
* hazard reaction time (eg., response to brake lamp onset);
* hazard detection (eg., liklihood/distance of detecting hazard);
* following distance, and
* speed maintenance.

There is general agreement that, for example, a decrease in hazard detection probability or increase in hazard detection reaction time will ultimately result in some increase in the probability that a crash will occur. Of the foregoing first level measures lane tracking and hazard detection response time, distance and/or liklihood are probably those most appropriate for in-cab device safety assessment as well as those most readily measured.

A second level, not as clearly related to accident involvement likelihood, includes driver and/or vehicle sub-system measures which are related to the first level but perhaps not so clearly related to crash likelihood. It can be inferred that performance at this sub-system level may affect performance on the higher system level measures and consequently on accident involvement. These sub-system performance measures include:

* steering wheel reversal frequency/rate/magnitude;
* glance frequency and duration;
* "attentional demand";
* "spare capacity," and
* secondary task performance.

In considering potential evaluation performance measures, both face validity and statistical validity must be considered. The higher level system measures tend to have greater face validity and are more readily related statistically to the primary measure, while lower level sub-system measures, such as glance time are less direct or obvious measures of safety

performance. Of these second level measures glance frequency and duration are likely the most relevant in-cab device evaluation measures since look time frequency, duration and sequence establish how long and how often a driver's visual attention is directed at the device and consequently away from his primary visual task. Attentional demand and spare capacity cannot be measured directly but must be inferred from the observation of a performance decrement on another task or by subjective rating schemes. Steering activity, which is ultimately related to vehicle control and thus safety, has been used in attention research but, again, the safety implications of observed steering behavior are not so clear.

5.3.4 Performance Criterion

A performance "criterion" is the level of performance on selected measures which is considered acceptable. A criterion may be a relative one, e.g., a specified difference from a standard or baseline. An absolute criterion would be that the number of glances required to operate a device function adequately.

Often there is considerable debate regarding performance criterion level acceptability for surrogate performance measures. While most would agree that any increase in crash rate is not acceptable, questions arise as to an acceptable level of hazard detection probability, for example.

5.4 DRIVER WORKLOAD DESCRIPTION AND QUANTIFICATION

5.4.1 Problem Statement

Prior to discussing more costly formal evaluation techniques, an approach to the quantative measurement and description of truck driver current workload is outlined. Published literature regarding quantitative or even qualitative assessments of truck driver workload, unfortunately, is virtually nonexistent. In the absence of typical truck driver workload measures an evaluation of additional in-cab device workload demand is not possible. Thus, a necessary prerequisite to such evaluations is the establishment of baseline truck driver workload, i.e., visual and attention demand in current truck operations. The foregoing review of truck in-cab display devices clearly indicates that use of many devices can place heavy visual and attentional

demand upon drivers and that demand may not be compatible with the primary driving tasks of forward roadway viewing, attention and vehicle control. One method of evaluating safety of in-cab device use is based on measurement of the additional load imposed by the device in question on the normal load imposed by conventional instrument tasks and primary visual/attention driving tasks.

5.4.2 Research Plan Overview

A research program to obtain this basic workload data is envisioned in which a sample of drivers of medium/heavy trucks employing conventional instrumentation are outfitted with an off-the-shelf eye tracking system in order to measure driver looking behavior as he/she drive over preselected routes representative of typical driving environments. The eye tracking/recording device provides a video record of the driver's visual scene upon which is superimposed a mark or cross hair element identifying the location of each glance made at instruments, controls, mirrors or the frontal scene. A digital on-screen clock records elapsed time which is used to quantify looking time, frequency and sequence, at each in-cab device as well as mirror and exterior roadway/traffic elements.

Quantitative measures of glance frequency, glance duration, glance sequence, as well as total task time, etc. would be obtained for all looking behaviors as a function of driver and environmental variables. The resultant visual demand measures or derivatives thereof would provide a baseline description of driver visual workload or visual demand. These measures can be subsequently used as a baseline for assessing the impact of integrating additional load imposed by additional tasks required by adding or modifying in-cab display devices. While additional measures of "attention" demand, i.e., cognitive mental workload, are desirable, the method of obtaining such measures is presently unclear but should be further considered. Visual attention, e.g., looking behavior , may, however, be indicative of cognitive workload.

5.4.3 Research Task Descriptions

5.4.3.1 Develop In-Vehicle Recording and Data Reduction Equipment and Procedure

Develop In-Vehicle Recording Instrumentation

A system for recording on video the visual scene as well as eye fixation points, is proposed. Available off-the-shelf devices, including Applied Science Laboratories Model 210, should be reviewed to select reliable, accurate, cost-effective hardware. The 210, for example, is comprised of a head mounted video lens, eye tracker spectacle-mounted sensors and an electronic "box" to process signals. Signals feed directly into a video recorder. An additional time signal generating minutes, tenths and hundredths of minutes input to the video recorder would provide elapsed time measures. In-cab real time looking behavior would be monitored via a small screen portable video monitor. The monitor would also be used for periodic equipment calibration checks.

In addition to driver looking behavior measurement, it is desirable to obtain measures of driving quality. Earlier it was noted that for passenger car driving lane line crossing frequency it was highly correlated with task required glance frequency. Consideration should be given to methods of continuously measuring lane line crossing frequency and time for subsequent correlation with visual load measures. Perhaps such crossings could be indicated on the video recording by the ride-along experimenter using a pushbutton. Alternatively, they may be recorded using a separate video camera synchronized to the eye movement recorders.

Design Data Reduction Equipment

Video cassette recordings containing approximately 1 hour of data per run would be analyzed. Actual event rate of interest will be dependent upon pilot studies. The video recording will be viewed, probably at slow speed or using stop frame, and glances of interest, e.g., speedometer, mirrors, forward scene, RRM, air brake pressure, temperature, etc. would be identified and

timed. Due to the large volume of data to be reduced to quantitative form, an efficient method would be required.

5.4.3.2 Select Driving Scenarios; Vehicle and Driver Sample

Select Driving Scenarios

In conjunction with truck driving experts, e.g., driver, driver training instructors and DOT, driving scenarios would be be established. Conceivably the scenarios might be as simple as 1) high density city and 2) low density highway driving. A simple route representing such situations would be selected for all subsequent data gathering "runs." It is anticipated that 30 minutes each of city and highway driving per driver would be adequate.

Vehicle Selection

A late model truck with an extensive complement of conventional instrumentation would be selected and the following visual display/control tasks should be considered:

* Vehicle speed
* Fuel level
* Engine RPM
* Oil pressure
* Alternator
* Coolant temperature
* Engine oil temperature
* Side mirror checks
* Forward exterior viewing
* Radio adjust
* HVAC adjust, and
* Other available displays.

A sleeper model is desirable to provide additional space for in-cab recording instrumentation.

Driver Selection

At minimum, both driver experience and age are of interest. Young and older drivers with low and high experience and perhaps varying experience type (local vs long distance) should be represented. Drivers needing corrective lenses may need to be excluded if the lenses are incompatible with the eye tracking device. A minimum of ten novice and 10 experienced drivers should provide adequate data.

5.4.3.3 Develop Data Collection Procedures

A standard route appears to be essential to obtain an organized body of data for the twenty driver subjects. A subject driver would enter the cab at a start point and be provided with instructions. Equipment would then be installed and calibrated. The driver would then simply drive from point A to point B, while a ride-along experimenter operates/monitors equipment and records other data of interest. A preselected list of tasks of interest would be performed by drivers to assure driver understanding and to assure that all tasks are performed during a run. At the completion of a run, video tape would be screened for quality and data reduced for subsequent analysis.

5.4.3.4.Conduct Pilot Studies

A series of pilot studies are envisioned. These studies would investigate the adequacy of the route selected, identify recording equipment and procedural problems and provide actual data for evaluating the adequacy and efficiency of data reduction/analysis equipment and procedures. The pilot studies would result in modifications to equipment, procedures, etc., necessary to provide a data gathering method appropriate to research objectives.

5.4.3.5 Conduct Data Collection Runs

It is anticipated that 1 subject driver would drive the route per day. Allowing for scheduling and weather difficulties and the need perhaps to repeat runs due to technical problems, data gathering would be accomplished over a two month period. It is anticipated that "runs" will require only one

in-vehicle experimenter to calibrate equipment, monitor recording and manually record events of interest.

5.4.3.6. Data Reduction and Analysis

The purpose of the data gathering is to provide a quantitative baseline measure describing driver visual workload. A format would be developed for providing such a description.

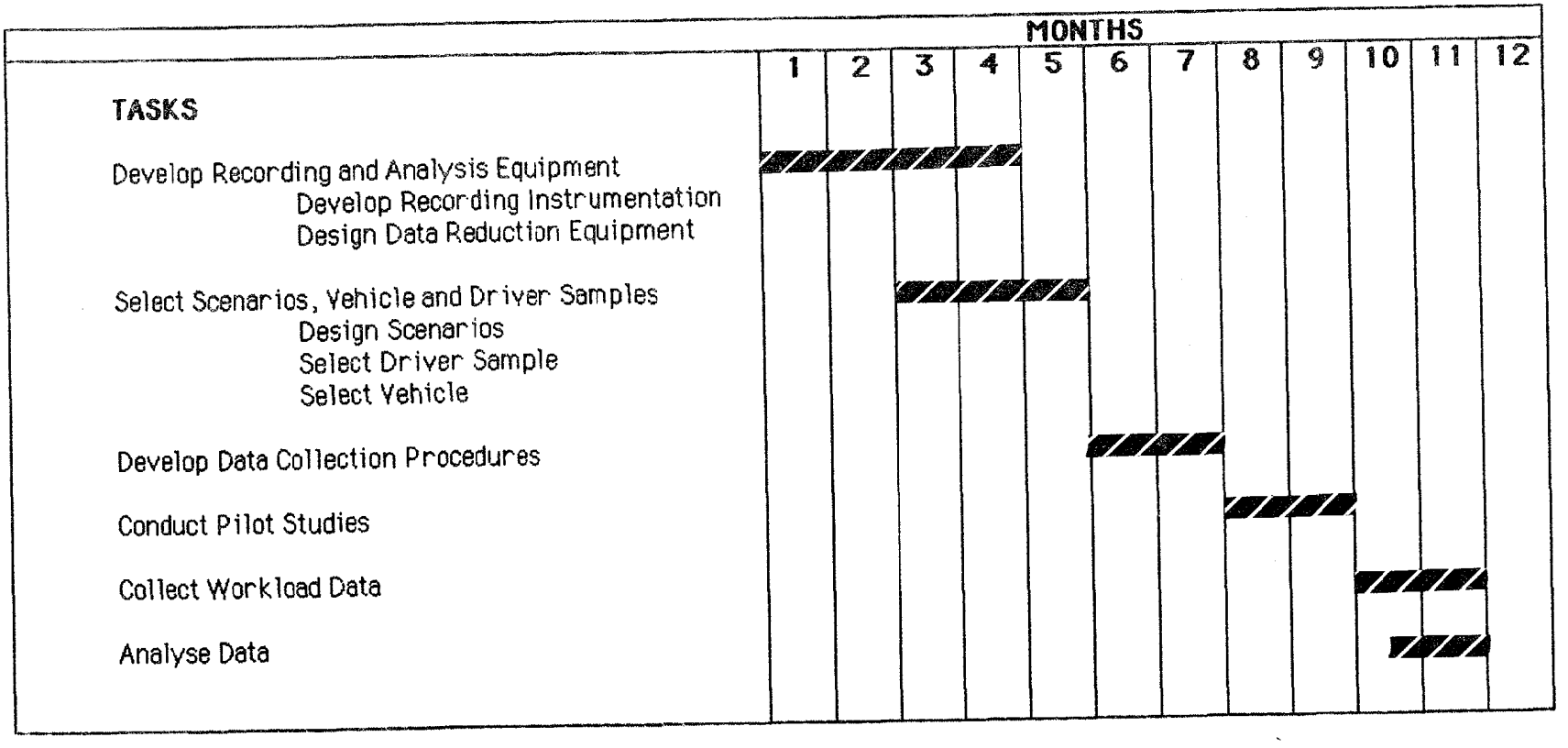
Video records containing driver scene viewed, eye track marks identifying the elements viewed (speedometer, vent, mirror, etc.) and digital elapsed time read out would be reduced to quantitative form. It is anticipated that video recordings would be reviewed at slow speed and visual tasks of interest identified. Subsequently, the glance duration, frequency and sequence would be quantified, organized and formatted to provide a meaningful quantitative description of visual load.

Analysis of data would provide, as a minimum, time spent looking at the forward scene and in-cab displays/controls as a function of driver, scenario and traffic variables. An important measure is believed to be time spent away from the primary task of viewing the roadway. Other derivative or composite measures describing workload should be considered. Notably, a method describing workload is desired which is compatible with the objective of assessing subsequent measures of load imposed by additional in-cab display devices.

5.4.4 Schedule

It is anticipated that the research plan can be completed in 9-12 months. The approximate time frame for major tasks and subtasks is shown in Table 5-1. Key tasks affecting schedule would likely be data reduction (a large amount of data would be expected) and the scheduling of truck and driver runs.

Table 5-1 Schedule of Tasks for Driver Workload Measurement



5.4.5 Level of Effort and Staffing

A one and one half man year level of effort is anticipated over approximately 9-12 months. A senior human factors scientist would be required 50% (1000 hours) time for planning, supervision, data analysis and reporting. A research associate or assistant level person would be be required full time (1000 hours) during pilot studies, data gathering and reduction/analysis while a second assistant would be needed for data reduction (1000 hours). In addition, an electronic technician is required for equipment selection, fabrication and installation, totaling about 150 hours.

5.5 IN-CAB DISPLAY DEVICE EVALUATION APPROACHES

As noted, there are several possible evaluation approaches to meeting desired objectives. Probably the most powerful, involving testing of actual devices under realistic simulated driving conditions, is described below followed by a discussion of some less powerful but also less costly methods. Section 4.5 describes an approach to obtaining quantitative descriptions of driver activities/workload during typical truck operation.

5.5.1. Simulation Test Evaluation

Simulation test evaluation involves obtaining system or sub-system surrogate performance measures of drivers during simulator or in-vehicle on-road or closed-course driving during performance of tasks required of an in-cab device and comparing those measures to cases when such in-cab display tasks are not performed. The difference, if any, in performance is the net decrement in driving safety due to device use. Given that a performance criterion has been established, e.g., a decrement from baseline performance of, say 5 percent or less, is deemed acceptable. Use of devices exhibiting performance exceeding that criterion could be restricted to non-driving situations. In-cab installation might be permitted but use during vehicle movement would be prohibited, for example, by interlock.

Assuming the acceptability of 1) the driving and device-use task simulation test fidelity, 2) performance measure validity and 3) the performance measure criterion level by various potential critics, this

approach is the most powerful available. It would most likely identify in-cab devices which compromise driving safety and increase accident likelihood. Unfortunately, such testing of each and every device is also the most expensive approach.

Rather than testing each device, consideration should be given to the feasibility of establishing a limited number of representative device task/equipment generic configurations (e.g., map reading, text entry, function selection) and the testing of only these fewer generic configurations. Unknown at present is whether one can satisfactorily generalize from a generic device to corresponding specific devices.

5.5.1.1 Alternative Test Facilities for Simulation Testing

Simulation testing can be conducted in a specially prepared driving simulator or in a vehicle either on the road or in a closed-course test track type situation.

5.5.1.2 Simulator Testing

Simulator testing has been used with considerable success in studying passenger vehicle/driver behavior as affected by a variety of vehicle, roadway and driver characteristics. Although some truck simulator studies have been performed, they are few in number compared to passenger vehicle studies. A recent simulator evaluation study (Stein, et al, 1987) was conducted to evaluate cellular telephone type and in-vehicle location in passenger cars. Although conducted in a passenger car setting, this study has many elements in common with in-cab display evaluation requirements.

The preferred simulator for research studies is an interactive system in which a computer-generated display system provides the appropriate changes in the drivers' visual scene as a function of the driver's control actions and the vehicle's characteristics. However, it is possible that modified truck driving simulators used for driver training may have a role in an in-cab display evaluation program. Training simulators generally have limited interaction but do provide motion picture display of the roadway as well as various driving tasks, based on standard and emergency response scenarios.

Simulator studies of in-cab devices would allow a direct examination of in-cab device use on driver performance variables such as lane position control, speed maintenance, response to road signs and signals, time delay to initiate appropriate truck driving actions such as braking and shifting actions, and response to emergency situations. They provide a capability to simulate a variety of scenarios in an interactive task situation and to generate relevant driver/vehicle performance variables. Also, results can be related to on-the-road driving performance.

Simulator studies, however, are quite time-consuming and expensive and might not be appropriate for application to every candidate device. Their main use might be to provide a tool for investigating and developing evaluation criteria and, especially, acceptable performance limits. An extensive analysis of technical approaches and visual simulator requirements for research in vision and driving by Burg (1977) is quite relevant to current evaluation needs.

5.5.1.3 In-Vehicle Testing

In-vehicle testing has many elements in common with simulator testing in that the emphasis is on realistic driving situations. For some aspects of truck driving, in-vehicle testing would be highly desirable, especially for those perceptual tasks requiring the full visual world such as backing and mirror use and in situations in which physical displacement due to vehicle acceleration and vibration are relevant to evaluation. In addition, it is likely that some level of examination of in-cab devices in a variety of truck cabs should be an essential part of an evaluation program to study problems of physical placement of display devices, relative to the user, and their interaction and interference with other control and display devices in typical cab layouts.

However, in-vehicle testing presents several problems. The range of scenarios is generally more limited than can be presented in a simulator, especially in regard to emergency tasks. Constructing and instrumenting an appropriate test range is an expensive task as is maintenance of such a test facility and the actual running of tests. Data are generally less reliable and more limited than can be obtained in a simulator. The major use of in-

vehicle testing, therefore, is probably for obtaining "check points" for device operation and task loading in actual driving situations as well as for physical placement and interference studies.

5.5.2 Other Evaluation Approaches

There are other approaches for meeting the objectives of evaluating in-cab display device compatibility with driving safety. While there are obviously many variations of each, three different general approaches are described below. They are 1) task analysis, 2) computer modeling and 3) critical performance criterion.

5.5.2.1 Task Analysis Approach

This type of analysis can be conducted at various levels of detail. In its simplest form one could simply assemble a group of experts, discuss the use of a given in-cab device at different points in a driving scenario and obtain a consensus as to its safety. This approach, with some structuring as to evaluation criteria, may be quite useful in the early stages of an evaluation program in order to obtain input from knowledgeable users of truck equipment.

A task analysis approach to workload evaluation would involve the following elements:

1. A breakdown of the driving task into a series of subtasks with a workload and time to complete estimate assigned to each subtask.

. Generation of a time-line for each driving scenario in which the subtasks are sequenced appropriately and the workload is calculated as a function of time.

3. Determination of the task requirement of the in-cab device and addition of its task loading to the driving time-line in order to determine its impact on the total workload.

Note that the task requirements of the in-cab device will have to be determined in some manner whatever the approach. Alternatives could include estimates using "standard" tables of times for task elements (looks,

keypresses, etc.) compiled especially for this purpose or actual measurement of operation times in simple laboratory or in-vehicle situations.

A more formal development of the task analysis model requires quantitative assignment of time and workload values for each subtask and a specified procedure for combining them to get total workload. This procedure depends less on expert judgement but it is also subject to error because of its dependence on limited quantitative data.

The task analysis approach is a relatively inexpensive one which lends itself to global "yes-no" decision with respect to the acceptability of a given device during a given driving task. The cost is low enough to enable it to be applied to all devices that fall into a "possibly hazardous" category. In addition, this approach could be supplemented by more sophisticated approaches. Although driver tasks can be analyzed and specified (such task analyses are available) the assignment of workload levels for each subtask and combination of workload over subtasks presents difficulties. The most workable approach is probably a qualitative one in which the driving task analysis combined with the device task analysis provide a framework for expert judgment.

5.5.2.2 Computer Model Task Workload Analysis

This technique is a computer implementation of the task analysis approach discussed above. The computer allows variability of both scenario conditions and operator response to be introduced as well as the calculation of a variety of criterion measures of workload. Such computer programs have been developed in the context of aerospace systems (e.g., the SAINT model) and motor vehicle system evaluation (e.g., DRIVEM). It is recommended that their application be considered for in-cab device evaluation, especially if the objective is a broad approach to driver/vehicle interaction research. In addition to the advantages previously listed for the task analysis approach, computer modeling enables a large number of conditions and variations to be inexpensively examined and a more detailed computation of workload versus time is possible. In addition to the difficulties previously listed for the task analysis approach, any application of computer modeling of human/machine interaction must be questioned until acceptable validity is demonstrated.

5.5.2.3 Critical Performance Criterion Approach

The principal load imposed on driver users of supplemental in-cab display devices is visual, that is, visual attention is essential for operating pushbuttons or other controls and to view entries or data on information displays. Some devices, in addition, may impose a heavy demand on a users "attention," an elusive concept often cited but poorly understood and difficult to measure. Many cellular telephone users cite the attention "capturing" aspect of the conversation as being far more unsafe than are pushbutton/dialing activities.

If one could establish the maximum visual attention "spare capacity" of drivers, that is, the amount of permissible vision/attention away from the forward roadway primary driving task which is compatible with safe driving, perhaps a simple pass/fail performance criterion could be established for device evaluation. For example, if it could be determined that crash likelihood increases when a single look away from the primary visual task exceeds, say, 2.0 seconds and/or also increases when more than 5 successive looks are required, a simple criterion might be available for evaluation (See Section 4.5).

Anecdotal experience indicates that we, as drivers, are unwilling to look away from the road ahead for more than very brief periods. This was demonstrated by Senders (1966 and 1969) some 20 years ago. Also, mirror evaluation research indicates that drivers, when attempting lane change decisions, make successive looks at rear view mirrors which rarely exceed two seconds. Instead of making one six-second look, drivers will make four 1.5 second looks to gather needed information. The recent research on looking time and frequency imposed by in-vehicle tasks (Antin, 1986) further verifies these observations.

On one hand, even the shortest glances away from the primary vision task will theoretically increase crash likelihood since the probability of response to any event occurring during that period is reduced. On the other hand, drivers do use side mirrors, observe conventional instruments and operate existing controls. Thus, we have historically been willing to accept some, though perhaps small, increase in crash likelihood.

Zhwalen has developed a theoretical model based upon glance frequency and duration for the evaluation of vehicle displays. Conceptually, it defines a maximum limit on glance time as a function of the number of glances required. If only one or two glances are required they can be longer than if 3 or 4 glances glances are required. Such a model could serve as a foundation for pursuit of this type of an approach to device evaluation. This approach is appealing because of its simplicity. Given a valid model, i.e., one which demonstrates that crash rate increases or that surrogate performance measures are degraded as a function of glance frequency and duration demanded by an in-cab device, evaluation of devices becomes relatively simple. In fact, evaluation might ultimately be unnecessary since manufacturers could integrate such performance criteria into original device designs.

Simple Criterion Evaluation Approach: An Example

The following illustrates one possible approach to evaluation which expands on the above simple conceptual model.

It is assumed that the driver's interaction with most information display devices can be characterized in terms of a "transaction" which has a beginning and an ending time. That is, at the time the driver decides to use the device he or she initiates a sequence of looks, keypresses, mental processes, etc., each of which takes a given amount of time. Each operation in this sequence is an "interaction" which can be characterized by a device-required duration. After some number of interactions over a period of time, it is assumed that the driver has achieved the purpose of the transaction and ceases to interact until the start of the next transaction.

A somewhat complex example of the above process would be using a car phone in which the driver may consult a reference list to obtain a phone number code, keypunch the code number into the phone, view the display to check the number and status, press the "send" button, listen for connection, conduct the conversation and then press the "end" button. Each of the steps listed above might involve several "interactions," with the entire sequence being the "transaction." A simple example would be that of reading a refrigeration trailer temperature display that is mounted on the trailer side that needs to be viewed from the left-hand rear view mirror. In this case the

entire "transaction" would likely be completed with one "interaction," consisting of a glance in the rear-view mirror.

Given the above framework, the following evaluation measures are suggested:

1. SINGLE INTERACTION TIME - the time for a single interaction with the device. Single interaction times might need to be determined separately for different types of interactions (looks, keypresses, etc.). This measure characterizes the distraction time generated by use of the device.

2. SINGLE INTERACTION RATE PER 10 SECONDS - the number of single interactions in successive 10 second periods for normal use of the device. The intent of this measure is to characterize the short-term distraction generated by use of the device during a complete transaction. (The use of 10 seconds is somewhat arbitrary at this time and it is subject to revision.)

3. PERCENT DISTRACTION PER 10 SECOND PERIOD - the above measure is converted into a percentage.

4. TRANSACTION DURATION - the amount of time to complete one transaction.

5. NUMBER OF INTERACTIONS PER TRANSACTION - the total number of interactions required to complete one transaction.

6. TRANSACTION DURATION - the total duration of a transaction.

7. PERCENT DISTRACTION PER TRANSACTION - the ratio of (5) and (6) above.

The above framework is based on the following assumptions:

1. A single interaction of whatever type should not exceed a certain maximum criterion time.

2. The total amount of allowed distraction time for a short period of time should not exceed a certain maximum criterion time.

3. The total amount of allowed distraction time for a complete transaction should not exceed a certain maximum criterion time.

Maximum values must be established for the above criterion measures. Although this could be done to some extent by analysis of available driver performance data, combined with truck driver task analyses, it is expected that research work of some type will be necessary to develop final maximum criterion values. In particular, it is expected that some types of simulation or in-vehicle studies will be required.

5.6 SHORT AND LONG RANGE PLANS

The inventory of supplemental in-cab devices identified significant numbers of devices currently on the market and it is indicative of substantial growth in the near future. Also, preliminary review of device designs and design concepts and the fact that their benefits are derived in large part from use during driving and not during normal stops suggests a very real potential for degraded roadway safety. The heavy visual/attention load required by use of at least some devices or certain device functions, clearly indicates the need for immediate, as well as long term, activity to substantially reduce and ultimately eliminate the reduced safety implications.

5.6.1 Short Term Objectives and Approaches

5.6.2 Short Term Objectives

Depending upon overall DOT objectives outlined earlier (guidelines, regulation, basic research), short term objectives which are compatible with the overall objectives should be established. The only feasible short term (1-2 years) objectives appear to be a 1) further definition of the problem, 2) identification of areas of immediate concern and 3) the dissemination of findings to the manufacturing and user communities. In addition, short term existing basic human factors design guidelines, conspicuously absent in many devices reviewed above, should be promoted.

5.6.1.2 Short Term Approaches

5.6.2.1 Refine Problem Definition and Scope

This study represents the first serious examination of the potential problem of in-cab display devices and at best has identified device types, estimated use and potential problem areas. A representative sample of devices should be selected for immediate detailed examination of driver/device interface characteristics and operating requirements. Such examination will further define the extent and magnitude of the problem and suggest areas of major concern.

5.6.2.2 Develop Relevant Device-Use Scenarios

Standard scenarios for truck operations are considered an essential tool for any evaluation of in-cab displays. The interaction between driver and typical information display systems is typically intermittent. As the safety consequences of any device may depend on the particular driving situation at the time the device is used, it is necessary to evaluate devices under a range of normal and emergency driving situations. Standardized evaluation scenarios would be useful in conjunction with nearly all evaluation techniques and would assist in the comparison of results obtained by different investigators or evaluation centers.

Two types of scenarios are suggested:

(1) Rural/highway driving to emphasize driver tasks such as shifting and braking on upgrades and downgrades, curve following, overtaking and lane changing, response to wind gusts and low workload conditions.

(2) Urban driving to emphasize driver tasks such as turning, backing, mirror usage, lane changing, shifting and braking in traffic and navigation.

The inclusion of emergency situations within each scenario should also be considered. The scenarios should be structured such that they could be implemented for a "paper and pencil" workload analysis, a computer analysis, a

simulation study or an in-vehicle study. Obviously, not all of the tasks can be included in each type of analysis or study (e.g., emergency response would not be included in an in-vehicle study) but it should be possible to design a "core" set of driving tasks that could be used in all evaluation systems.

The standardization of scenarios is considered essential in order to provide an acceptable baseline performance situation against which the effect of in-cab devices can be evaluated. The selection of scenarios and scenario tasks can be based on existing task analyses of truck driving and the curriculum for truck driver training programs. In addition, consultation with truck driving training institutes and other industry sources should be included in the scenario development program.

5.6.2.3 Conduct Task Analyses

A task analyses should be conducted for the operation of each device of interest. This will identify controls and displays used, describe information processing requirements and provide qualitative and, to some extent, quantitative measures of driver load imposed by device use. Existing truck driving task analyses and behavioral requirements identified in truck driver training programs will establish the basic driving load and requirements. Superimposing additional task requirements of in-cab device use can be used to establish heavy loading and expert judgement can be used to determine excessive requirements imposed by devices or specific device functions.

5.6.3 Long Term Objectives and Evaluation Plan (5 year)

A five year time frame enables setting of objectives having a greater impact on in-cab use and driving safety and allows for the conduct of necessary research to meet such objectives. This time frame would permit continuing industry/government cooperative efforts in establishing guidelines and/or would permit development of a basis for setting standards and enforcement procedures by DOT. Likewise, at the end of this period considerable research data pertinent to the generic problem of driver/in-cab device interface could be assembled.

5.6.4 Development of a Simulation Test/Research Facility

The availability of a dedicated simulator facility in this country for research on driver/display control/information processing would solve many future problems similar to the supplemental in-cab display device safety issue under consideration here. It is anticipated that such devices will proliferate not only in trucks but in all motor vehicles. High priced automobiles already are incorporating touch screens permitting a driver to "call-up" all sorts of relevant and irrelevant information. The Japanese are discussing the integration of computerized data bases allowing drivers to search out local entertainment at movie theaters as well as shopping data. The implementation of such concepts will assure ongoing difficulties regarding decisions of acceptability and effects on safety.

There exists today virtually no empirical data upon which to base a rational method for assuring that such devices do not degrade on-road safety. Driver visual, motor and attention loads must be defined, described and measured quantitatively before one can determine whether additional demands imposed by novel displays can be safely met by drivers. A simulator research capability would clearly be a key tool for providing this needed research data.

While simulators have always been relatively expensive, considerable experience has been gained over the years and advancements in computer technology should enable the development of a useful cost-effective system. Expensive realistic motion capability appears unnecessary, for example, since the focus is upon internal and limited external visibility, and displays and controls and driver attention and other cognitive processes.

A serious examination should be made of DOT objectives and approaches to the current/future display device problem, since it would provide a facility not only for test evaluation of specific devices but could also produce the necessary research data for future design and/or regulations regarding driver/vehicle interaction effectiveness and safety.

6.0 CONCLUSIONS AMD RECOMMENDATIONS

6.1 CONCLUSIONS

6.1.1 Growing Demand For Electronic In-Cab Devices

The economic societal benefits inherent in the availability of supplemental in-cab devices to truck drivers and fleet owners in terms of operating efficiency, scheduling, fuel consumption, driver control, etc., will likely lead to a proliferation of such devices in the near future. Continuing advances in electronic technology, decreased production costs due to greater volume and increasing traffic congestion and delays will no doubt contribute to this growth. It should be emphasized that many of these devices are also applicable to the automobile user and similar growth, can be be anticipated within that population of road users.

6.1.2 Safety Implications of Device Use During Driving

Over 50 supplemental in-cab display devices were inventoried. A few appear sufficiently simple to operate and their use during truck driving should add only slightly to the safety problem currently existing due to conventional truck instrumentation and controls. The addition of <u>any</u> additional task, however trivial, theoretically will have <u>some</u>, albeit small, impact on safety due to the additional visual attention demand. A few other devices, however, notably map navigation, text communication and some vehicle information systems, are quite complex. Use of one or more of their available functions will undoubtedly result in a significant decrement in driver performance and, ultimately, in driving safety. There is a third group of systems, possessing one or more functions, for which the impact of their use during driving is not clear from the superficial analysis possible, and a formal evaluation is required. Clearly, there is an urgent need to prevent at least some devices i.e., those which are incompatible with driving safety, from being used and that this be initiated as quickly as possible. Approaches to preventing their use include either or both regulation and/or establishment of design and user guidelines.

6.2 Recommendations

6.2.1 The Need For Intervention

The increasing availability and use of hazardous electronic in-cab devices by the trucking community, as well as by the private automobile driving sector, clearly indicates the need for some type of immediate, as well ongoing, intervention. Such intervention could take the form of Federal Regulation, industry self-regulation or a combination of both. In any event, the current absence of design guidelines and evaluation methods strongly indicates a need for fundamental research on truck driver workload. Without an adequate understanding of the workload problem, adequate solutions are unlikely. Both short term and long range approaches to device evaluation with regard to on the road safety are recommended.

6.2.1.1 Short Term Intervention

In the absence of satisfactory evaluation methods, an interim plan should be implemented to 1) promote an awareness within the device manufacturing industry and to users of the safety problem potential, 2) assemble and provide to designers applicable existing human engineering design guidelines, 3) identify short term research and analysis needs, establish programs to meet those needs and disseminate results, 4) foster cooperation among the research, design and user communities and 5) conduct basic research to establish quantitative measures of truck driver workload essential to subsequent evaluation activities.

6.2.1.2 Long Range Research And Evaluation Plans

While short term intervention is conceived as a stop-gap measure directed toward having an immediate impact on the design and use of existing devices, a long range plan is necessary to assure development of acceptable, cost-effective evaluation techniques and to provide satisfactory design data. A five year plan is recommended to 1) establish design guidelines, regulatory objectives and evaluation methodologies, 3) sponsor necessary research that is coordinated with other agencies, foreign countries and independent laboratories and 4) develop the necessary facilities for research and, in particular, evaluation of subsequent generations of anticipated devices.

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APPENDIX A. Integrated/Single Displays; Selected Literature

Easy Weigh (204).....A-1

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Fuel Tach (225).....A-4

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"E-Z WEIGH"

Filling An Important Need

Now, owner-operators of air suspension rigs can have a weight monitoring system that fills all your on-the-spot weighing needs—without incurring the high expense of systems used on spring suspensions.

Martronic Engineering has developed *"E-Z Weigh "* with the owner-operator in mind. You have needed an on-board monitor which is electronic, which has remote display in the cab for easy viewing, which has accuracy, which is a breeze to install, and which is priced so reasonably you couldn't ignore it. The result is *"E-Z Weigh."*

Why On-Board Scales

You know the problems: if you're underweight, you're losing money. If you're overweight, you could be looking at some stiff fines. Also, overweight can take its toll on your truck. And, if you're doing transfer work, you know how much time is wasted making platform scale runs. Now you can monitor weight while you're loading and cut down as much as two-thirds of unproductive weighing time.

How It Works

"E-Z Weigh" plugs right into your air suspension. Air lines connected to the air pressure bags transmit the pressure to a small electronic console which computes the weight. This information is sent in electronic signals to the digital display unit mounted in the cab. The display unit flashes the weight in thousands of pounds (to the nearest hundred pounds) on a bright LED indicator which can be seen easily day or night. Since *"E-Z Weigh"* measures weight for both tractor and trailer, the driver gets separate readings for each axle set through automatic cycle or with a manual control switch on the display unit.

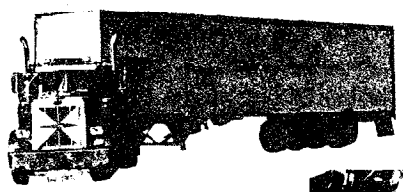
Pricing

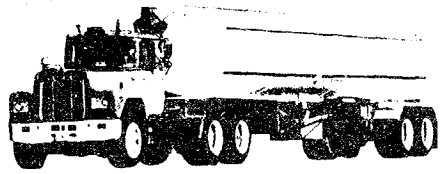
Because of the easy and natural fit into the air suspension system, there is no need for hard parts or other expensive components. As a result, Martronic Engineering is able to offer *"E-Z Weigh"* at an extremely affordable price.

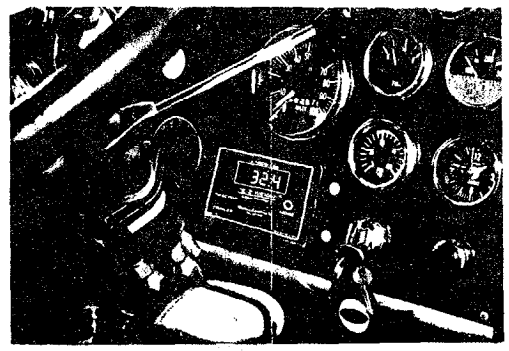
The entire *"E-Z Weigh"* package is available for only $959.00. And it is important to point out that the scale system monitors both tractor and trailer for the one low price.

Warranties and Guarantees

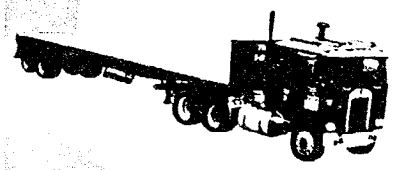
Martronic has full confidence in *"E-Z Weigh,"* and so should you. The company is offering a manufacturer's warranty of one full year on the workmanship of the product. And it is providing a 30-day, 100% money-back guarantee if you are in any way dissatisfied with the performance of *"E-Z Weigh"*.



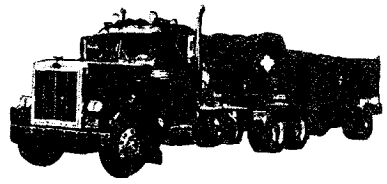




Ideal for Any Air-Suspension Truck

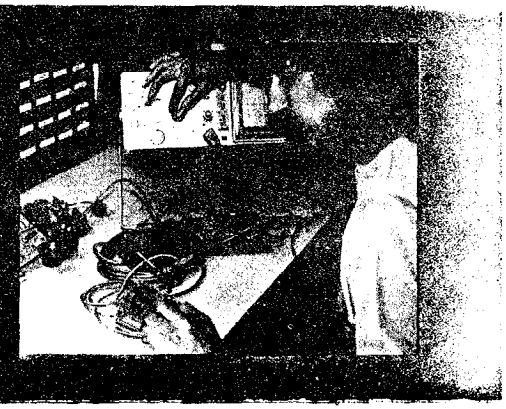


No matter what you haul, no matter what type or make of truck you have, if you're riding on air suspension, *"E-Z Weigh"* can be an important part of your day-to-day work life. Each truck and each industry has its own requirements, but there is always one question which can now be answered by *"E-Z Weigh"* whatever you're driving: Are you carrying your safe or legal limit?

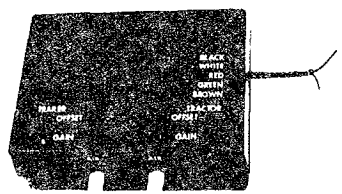


The Company Behind *"E-Z WEIGH"*

For more than a decade, Martronic Engineering, Inc. has been solving problems for the automotive, construction and agriculture industries through the use of leading-edge electronic technology. Approaching the unique challenge of developing a load monitor for air suspension trucks, the company took a page from aerospace technology and applied it to the trucking industry. Martronic understands its audience. The guidelines they followed in designing *"E-Z Weigh"* were provided by experts in the transportation field, including trailer manufacturers, professional truckers and specialists on its own staff.



Electronic Module



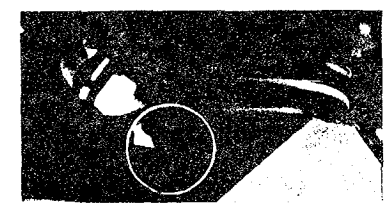
The brain and heart of the system is a small electronic module. This unit collects air pressure data from the air suspension bags, decodes it and sends signals to the display unit for readout. The unit is generally mounted under the dash so that calibration adjustments can be easily made. Five wires leading from the display unit cable fit quickly into holes color-coded for no-problem connection. Air hoses leading to the suspension are easily connected to the module. A built-in electrical line is ready for attachment to the truck's normal 12-volt power.

Display Unit

The display unit has an LED electronic digital readout, measuring weight in thousands of pounds. A "mode" button allows the operator to either automatically or manually alternate weight readings for the tractor or trailer. Red LED arrows point to the axle set being monitored.

Quick Connect

Connection to Air Suspension



There are a number of options for attaching the air lines to the air suspension system. One of these is a connection directly after the leveling valve at the air bag. Attachment can also be made by splicing the air line directly into the lines connecting the air bags together.

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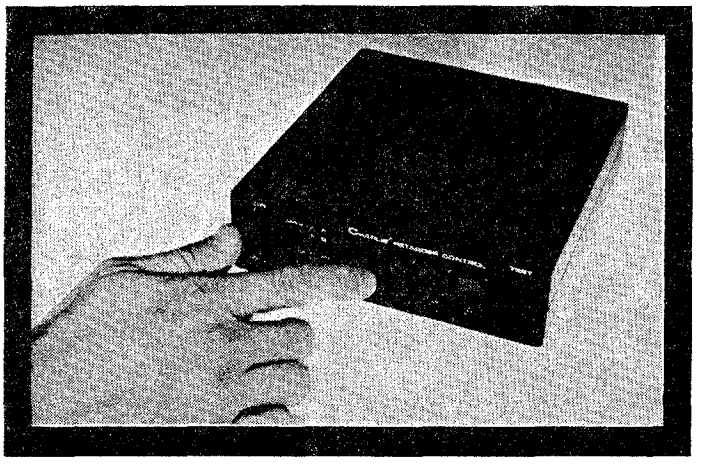
80 West Easy Street, #5, Simi Valley, California 93065 (805) 583-0808

Charlie®

Retarder Control



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—**CHARLIE** prevents engine stall due to lock-up of engine braked wheels on slippery surfaces.
—Nevada Automotive Testing Center

—**CHARLIE** is the best safety device the drivers have ever had on a truck.
—Chief Dispatcher, National Corp.

—**CHARLIE** has saved us many dollars in labor, repairs, breakdown time and driving time.
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Electronic dash offers digital displays

An electronic dashboard is now available as an option on all trucks built by Marmon Motor Co., Garland, Tex. The microprocessor-based dash has been engineered to withstand severe vibration, and is covered by a 3-year/300,000-mi. warranty, according to sales and marketing manager Ron Owens.

A vacuum-fluorescent display helps make it easy for a driver to see each dash function. The display provides a real advantage, Owens claims, over the more commonly used liquid-crystal display for daytime visibility when the sun shines directly on the dash.

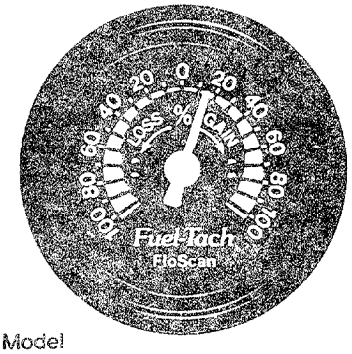
Standard digital displays include speedometer, tachometer, odometer, manifold pressure, water temperature, engine-oil temperature, oil pressure, transmission-oil temperature, pyrometer, front- and rear-axle air pressure, voltmeter, and fuel level.

Miscellaneous displays include turn-signal arrows and a high-beam indicator, as well as warning lights and buzzers for low oil pressure, low water, low air pressure, and high water temperature.

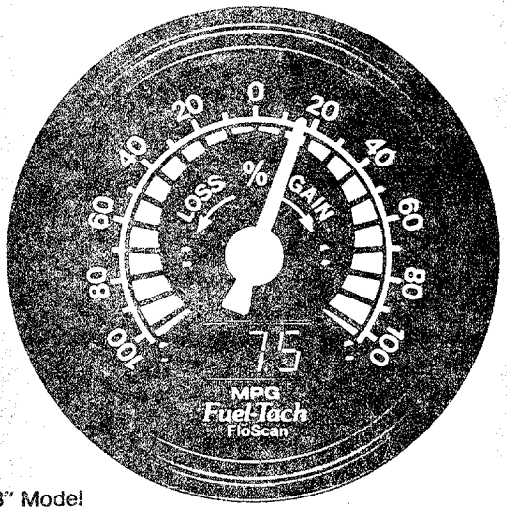
Circle 306 on reply card for more data

Fuel-Tach™

DIESEL FUEL COMPUTERS FOR Cummins ENGINES



2" Model
(Actual Size)



3" Model
(Actual Size)

DESCRIPTION

FloScan's new *Fuel-Tach*™ diesel efficiency computers are compact instruments designed to help the truck operator maximize fuel efficiency by choosing optimum gear and speed under all load, weather, road, and equipment conditions. Fuel savings of 10% to 15% are possible, paying for the installed cost of the system in only 3 months.*

The *Fuel-Tach*™ comes in two models. The 3" diameter model indicates instantaneous fuel efficiency *plus* trip average miles-per-gallon. The 2" model indicates instantaneous fuel efficiency only. Both instruments use advanced microprocessor technology (patent pending) and a wide-sweep analog meter for easy reading. The meter indicates the percent variation of instantaneous MPG from trip average MPG so that the operator knows if changing gear or speed will increase or decrease his fuel efficiency and by exactly how much. A digital display in the 3" model also shows trip average miles-per-gallon (to the nearest 0.1 MPG) or l/100km (metric version).

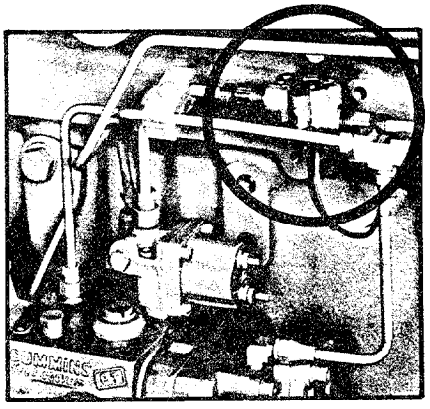
Installation involves no changes to the fuel system and has no effect upon engine performance. A single flow sensor is connected in the fuel line after the injection pump. The speed signal is obtained from either a speed sensor (supplied) which connects in the speedometer cable near the speedometer or an already installed electrical speedometer sensor (most models). The meter head fits in the panel or in an optional deck mount.

The *Fuel-Tach*™ system uses FloScan fail-safe diesel flow sensors (Patent 3,867,840) which have been installed as original equipment in more cars, planes, and boats in the U.S. and Europe than all others combined. FloScan products are manufactured under Ford Q-101 Supplier Quality Assurance standards.

*Based on 80,000 miles/year, 5 MPG average fuel consumption, fuel cost of $1.10/Gallon and *installed* cost of $300-$450 (depending on model).

FEATURES

- Two models fit 2-1/8" and 3-1/16" panel holes. 3" model comes with front mount ring. Deck mount for 3" model available as an option.
- In-truck calibration (required only for Digital Display in 3" model) insures maximum accuracy.
- Indirect illumination. Red LED Display in 3" model dims when headlights are turned on.
- Black or polished stainless steel bezels.
- ***NO*** effect upon fuel system heat balance or engine performance (ask for engine dyno test results).



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INSTRUMENTS & CONTROLS

Introduction

Lagonda's dash contains instrumentation which is by far the most advanced system available on any production motor car today. The instrumentation is computer controlled and monitors some thirty (30) functions simultaneously and best of all-- automatically. The computer termed AUDIT^{R}(Automotive Data Information Terminal) contains a total operation memory capability of 100K (100,000 bytes of data storage and manipulation). The computer also allows the flexability of speech programming for different world markets therefore making Lagonda the first truly international motor car. The computerized instrumentation is solid state and utilizes specially constructed CRT's (Cathode Ray Tubes), developed for the F-15 Fighter, so as to provide you the driver years of trouble free operation. The ADC (Automatic Dim Control) monitors ambient light and adjusts the intensity of the CRT's to the precise degree of intensity required for viewing in all light conditions.

(Refer to drawing 84-079)

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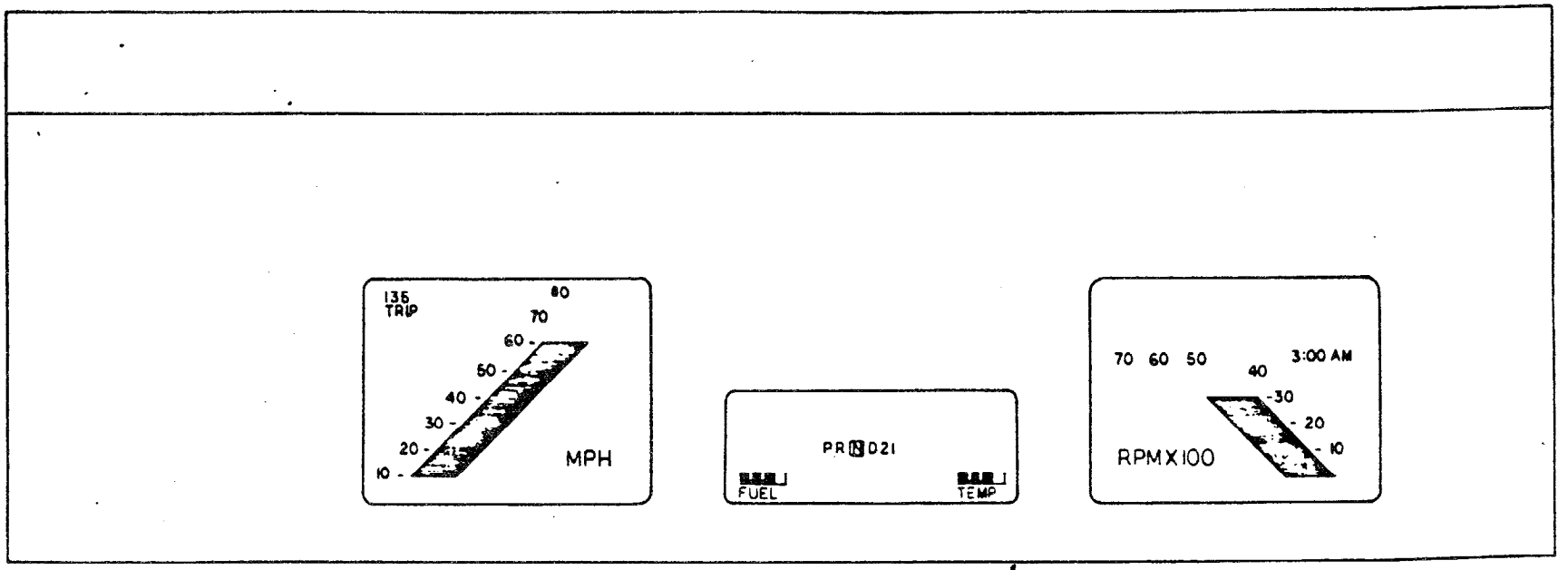
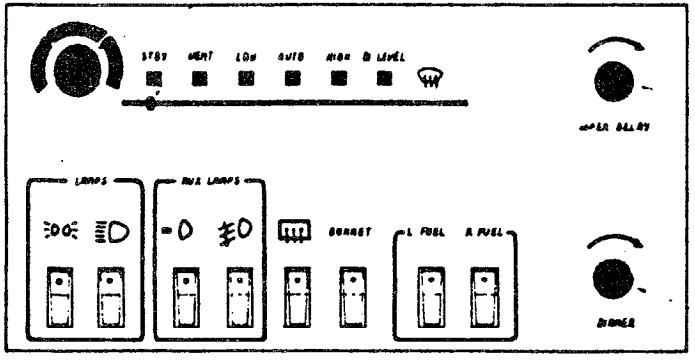


INSTRUMENT PANEL

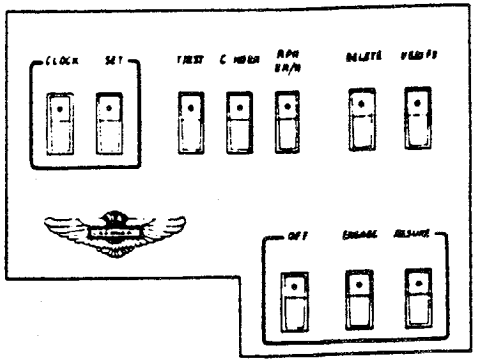
AIR CONDITIONING CONTROLS



WINDSCREEN
WIPER DELAY

COMPUTER SCREEN DIMMER

LH BINNACLE



RH BINNACLE

			JAVELIN CORPORATION
			LAG. INSTRUMENTS & CONTR

A-5.2

#226 B

INSTRUMENTS AND CONTROLS

SPEEDOMETER The car road speed is displayed in miles per hour or kilometers per hour which ever is selected via the binnacle touch key. In the miles per hour mode the speedometer indicates speed by incrementing the bar graph from 0 to 80 MPH and then rescales at 80 MPH to indicate speed from 80 to 160 MPH. In the kilometers per hour scale, the speedometer indicates speed by incrementing the bar graph from 20 to 160 KPH and rescales at 160 to 320 KPH.

TRIP Located at the top left hand portion of the speedometer screen is the trip counter. The trip counter logs miles or kilometers to the count of 999. Upon selection of MPH or KPH mode the computer recalculates th conversion and displays it with the appropriate scale. The trip counter may be reset by means of the T/RST touch key located on the right hand binnacle.

TACHOMETER The tachometer displays, revolutions per minute times 100, from 500 RPM to 7000 RPM. Therefore, when the bar graph is equal with the 30 numeric, the engine RPM is 3000 (30 X 100).

CLOCK The clock displaying hours and minutes, AM and PM, is located in the top right hand corner of the tachometer screen.

GEAR SELECTOR Located in the mid portion of the center screen is the gear selector indicator (PRND21). The selected gear appears in the reverse legend bordered with a cursor.

FUEL GAUGE Located in the bottom left hand portion of the center screen is the fuel bar graph. The fuel bar graph indicates the portion of fuel remaining in the fuel cell. Upon reaching 1/8 tank of fuel the computer will illuminate a fuel pump directly above the fuel gauge as well as the message "Low Fuel" directly beneath the gear selector indicator. This low fuel function may also be activated by turning the ignition switch to position number 2.

TEMPERATURE GAUGE Water temperature gauge is located at the bottom right hand corner portion of the center screen. Approximately half way on the temperatur gauge is normal operating temperature, approximately 95 degrees C. Approximately 3/4 way on the temperature gauge is 120 degrees C at which time the computer will, directly above the temperature gauge, illuminate the temperature symbol and in addition in the center screen, below the gear selector indicator, will write the message "High Water Temperature".

LIGHT TELL TALES Located in the upper portion of the center screen above the gear select indicator are the tell tale symbols for side lamps, spot lamps and fog lamps. Located upper most center portion of the screen is the high beam indicator,

TURN ARROWS Left and right turn arrows are located in the upper most portion of the center screen on either side of the high beam indicator respectivel

MESSAGE CENTER Located directly below the gear selector indicator, located in the center screen are two message centers. The "A" message center is positioned directly below gear selector indicator. The "B" message center is located directly below the "A" message center.

"A" MESSAGE CENTER The "A" message center contains eight mechanical failure warnings. These warnings are prioritized to appear in order of importance.

Low Oil Pressure
High Water Temperature
High Oil Temperature
Low Brake Fluid
Battery Charge
Bulb Failure
Low Fuel
Ice Warning

For example: If simultaneously the computer is directed to indicate "Low Oil Pressure" and "High Water Temperature" the computer will only display "Low Oil Pressure". The reason being that "Low Oil Pressure" has been assigned a higher priority message than "High Water Temperatur and consequently been deemed the most important message to be displayed to the driver.

"B" MESSAGE CENTER Listed below in order of importance are the "B" messages. The "B" messages appear in the lower portion of the screen below the "A" message center.

Seat Belts
Park Brake
Brake Pads
Low Brake Vacuum
Boot Open
Fuel Flap Open
Low Wash Level
Rear Window Defrost

Accordingly if the computer is instructed to indicate seat belt warning and brake pads warning simultaneously, the computer will determine that seat belts is the higher of the two priorities and therefore displays "Seat Belts" message in the "B" message center. Once the seat belts are fastened, the computer would then cancel the seatbelt warning and then display the brake pads warning.

TOUCH KEYS RH BINNACLE

CLOCK	Touch key. Operates fast setting function on clock display.
SET	Touch key. Operates slow setting function on clock display.
T/RST	Touch key. Operates trip odometer display reset located in the top left hand corner of speedometer screen.
C HORN	Touch key. Selects country (air) horns or town (electric) horns.
MPH KM/H	Touch key. Selects speed and trip display mode.
DELETE	Touch key. This switch will override "B" message warnings appearing in the "B" message center. Upon turning ignition off reset will affected so as to display "B" messages each time vehicle is started While the delete switch will extinguish "B" messages appearing, it will not eliminate ISO symbols which are associated with "B" message center, and displayed elsewhere on the message screen.
VERIFY	Touch key. This switch enables the computer systems check. If no messages are displayed in "A" or "B" message center, the computer enunciates "ALL SYSTEMS GO". If however warnings appear in "A" or "B" messages centers, the computer will enunciate "Warning". "B" messages may be deleted by use of the delete key at which point the computer will enunciate "ALL SYSTEMS GO".
OFF	Touch key. Manual disengagement of cruise control
ENGAGE	Touch key. Engages cruise control at any desired speed above 30 MPH (50 KPH) with the gear selector in DRIVE. Above 30 MPH continuous pressure on the touch key will gradually increase the speed of the car without the operation of the accelerator pedal. On release of t touch key, the speed at which the car is traveling will be maintaine until further intervening action. From 30 MPH the car may also be accelerated normally by use of the accelerator pedal and, at the desired speed, the cruise control facility may be engaged by touchin the "ENGAGE" key. The car will then maintain that speed until further intervening action. With cruise control engaged the car wil respond normally to the accelerator for overtaking etc.. and will resume selected cruise speed after the manoeuvre is completed. Use of the brake pedal de-activates cruise control, the previously selected speed may then be resumed by touching the "RESUME" key. Cruise control may also be de-activated by selecting "NEUTRAL" on the gear selector. However as there is some danger of inadvertently selecting REVERSE it is not recommended that the facility be de-activated in this way. To select different cruise speeds, accelerat or decelerate to the required speed and touch the "ENGAGE" key.
RESUME	Touch key. Re-engages cruises control at the previously selected after cruise control cancellation by use of the brake.

LEFT HAND BINNACLE

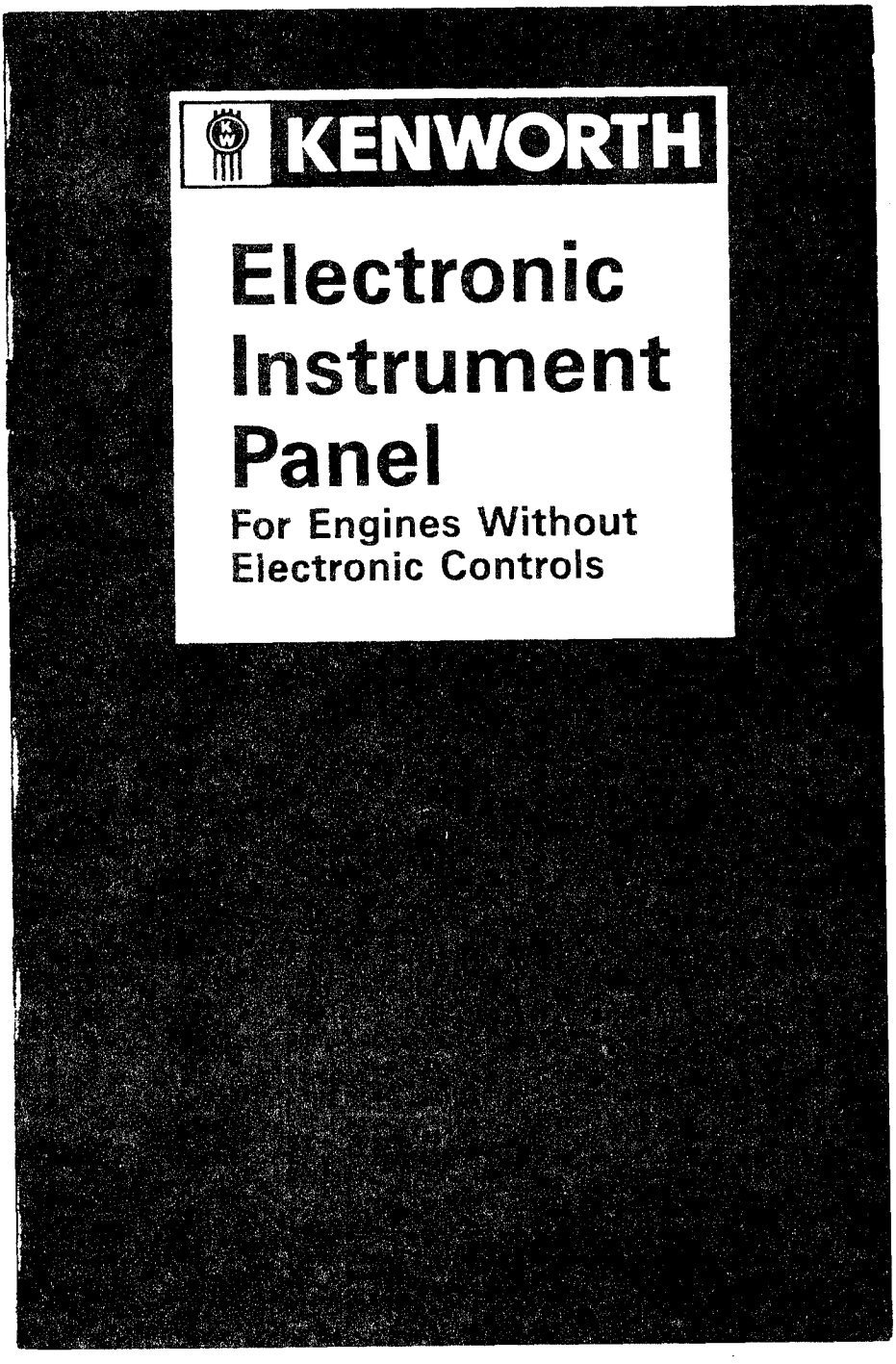
AIR CONDITIONING	Control knob. Selection of temperature to be maintained by air conditioning unit.
SLIDING LEVER	Control knob. Selects various air conditioning modes.
WIPER DELAYS	Control knob. Selects wind screen wiper sweep delay.
DIMMER	Control knob. Progressive dimming of instrument read out.

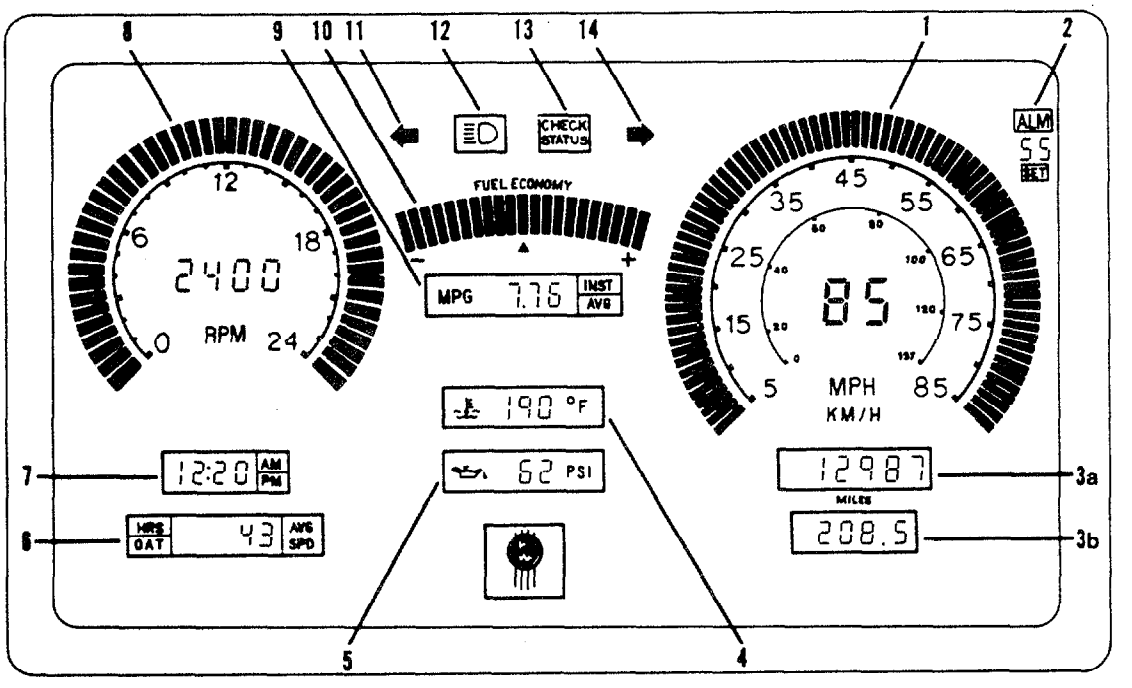
LAMPS

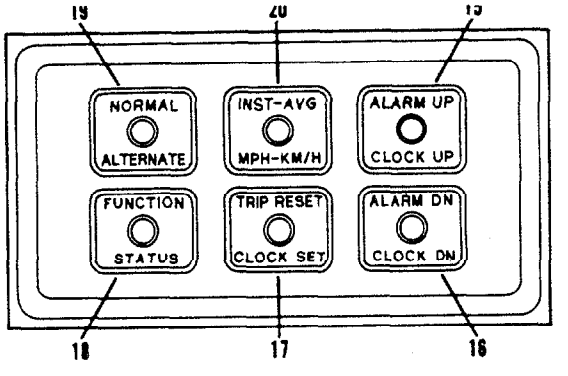
SIDE LAMPS	Touch key. Selects side lamps on or off.
HEAD LAMPS	Touch key. Selects head lamps extended (on) or retracted (off). Operates only with side lamps selected.

AUX LAMPS

SPOT	Touch key. Selects spot lamps on or off. Operates only with side lamps selected.
FOG	Touch key. Selects fog lamps on or off. Operates only with side lamps selected.
REAR WINDOW DEFROSTER	Touch key. Selects rear wind screen defroster on or off. This system will de-energize automatically after 20 minutes.
BONNET	Touch key. Operates bonnet latches.
LEFT FUEL	Touch key. Operates left hand fuel flap release.
RIGHT FUEL	Touch key. Operates right hand fuel flap release.


KENWORTH
Electronic
Instrument
Panel
For Engines Without
Electronic Controls





Item	Description
1.	Speedometer
2.	Alarm Set Speed
3.	a. Odometer b. Trip Odometer
4.	Coolant Temperature
5.	Oil Pressure
6.	Hourmeter/Outside Air Temperature (O.A.T.)/ Average Speed
7.	Time Of Day Clock
8.	Tachometer
9.	Average/Instantaneous Fuel Economy
10.	Instantaneous Fuel Economy

Item	Description
11.	Left Turn Signal
12.	Highbeam Indicator
13.	Check Status
14.	Right Turn Signal
15.	Alarm Up/Clock Up
16.	Alarm Down/Clock Down
17.	Trip Reset/Clock Set
18.	Function/Status. See item 6.
19.	Normal/Alternate
20.	Instantaneous Average/MPH-KM/H

NOTE: For items 15 through 20, see Auxiliary Control Panel, pages 10 and 11.

This vehicle is equipped with an electronic instrumentation package that uses liquid crystal display (LCD) technology to display information to the driver. The electronic display is accompanied by an auxiliary switch panel that allows the driver to access information and exercise features which, until now, have not been readily available.

The features and operation of the electronic instrumentation package are described below:

Speedometer

The speedometer is located to the right on the display panel. The circular, 80 segment bargraph displays vehicle speed from 5 to 85 miles per hour. A digital readout is located central to the bargraph and displays vehicle speed from 0 to 99 miles per hour. A standard magnetic sensor is installed on the transmission rear bearing cover to provide the signal for this display.

To change the bargraph and digital display to kilometers:

1. Press the NORMAL-ALTERNATE switch. This initiates the alternate mode.

2. Press the MPH-KM/H switch.

Kilometers per hour or miles per hour is indicated by an annunciator below the digital readout. Note that the odometer and trip odometer do not change from miles to kilometers.

Tachometer

The tachometer is located to the left on the display panel. The circular, 48 segment bargraph displays engine speed from 0 to 2400 RPM. A four character digital readout located central to the bargraph displays engine speed in 20 RPM increments. A standard magnetic sensor is installed in the flywheel housing of the engine to provide the signal for this display.

Oil Pressure

The oil pressure indicator is located in the center area of the panel directly above the Kenworth logo. This digital readout displays oil pressure from 0 to 120 PSI. The oil pressure sensor is located in the piping manifold behind the dashbdoard.

Coolant Temperature

This indicator is located above the oil pressure digital readout. The coolant temperature digital readout displays temperatures from 125° to 230° Farenheit. When the temperature drops below 125° F, the readout displays "cld" to indicate cold engine.

Average/Instantaneous Fuel Economy—Digital

This digital readout is located above the coolant temperature display. The driver can press the button marked INST-AVG to toggle the display for either average (for the accumulated trip miles) or instantaneous fuel burn in miles per gallon. Fuel burn data is provided for the electronic panel by flow sensors in the fuel lines. Caterpillar and Detroit Diesel engines require two flow sensors, Cummins engines require one. Annunciator lights indicate to the driver whether the display is showing instantaneous or average miles per gallon.

Instantaneous Fuel Economy—Analog Bargraph

This display is located above the digital readout for MPG. The 21 segment semicircular bargraph indicates fuel economy relative to the average MPG that has accumulated over the trip miles (as indicated on the trip odometer). The center segment always corresponds to the current average MPG. When the digital MPG display is toggled to display average, an annunciator light will light beneath the center segment to confirm that this segment represents average MPG. As instantaneous fuel economy becomes better than average, the bargraph "grows" to the right into the green. Conversely, as instantaneous fuel economy becomes worse than average, the bargraph "grows" to the left into the red. The bargraph is a tool for the driver to adjust operation of the vehicle to maximize fuel economy for any given driving condition.

Fuel Economy—Calibration

The fuel economy display has been calibrated at the Kenworth factory. Recalibration is required when the flow sensors have been replaced, or with Cummins engines, when work on the fuel pump has altered the fuel bypass ratio.

It is possible for the operator to recalibrate the display if it is found that actual fuel economy deviates from that which is displayed by the panel. The procedure is as follows:

1. Depress the NORMAL/ALTERNATE switch.

2. Depress ALARM UP/CLOCK UP and ALARM DN/CLOCK DN switches simultaneously. The current AVERAGE fuel economy figure will appear and the AVG annunciator light will flash.

3. Now depress ALARM UP or ALARM DN switches to adjust the AVERAGE MPG figure up or down to that which was actually observed.

4. The procedure is completed by depressing the TRIP RESET/CLOCK SET switch for at least 3 seconds. The panel will return to the NORMAL mode.

   NOTE: It is possible to negate the above procedure during steps 1, 2 or 3 by depressing the NORMAL/ALTERNATE switch. The panel will return to the NORMAL mode without being recalibrated.

A-6.4

Hourmeter/Outside Air Temperature (O.A.T.)/Average Speed

These three displays share a common space below the time of day clock. Annunciator lights indicate to the driver which information is displayed: HRS, O.A.T., or AVG SPD. The button marked FUNCTION on the auxiliary control panel allows the driver to select the information displayed in a cyclical manner:

O.A.T.

The digital readout displays ambient air temperature in degrees Fahrenheit.

HRS

The digital readout displays the accumulated hours of engine life.

AVG SPD

The digital readout displays the average speed: Trip miles (as displayed on the trip odometer) divided by the engine hours for the trip. The effect of idling time on average trip speed can be clearly demonstrated with this feature. Average speed is reset to zero when the trip odometer is reset to 0.0 miles. When the speedometer is switched to indicate kilometers per hour, average speed will also be indicated in kilometers per hour.

Time Of Day Clock

The digital clock is located directly below the tachometer. The readout displays hours and minutes and has annunciator lights to indicate AM or PM. The time is set by first pressing the NORMAL/ALTERNATE switch (to put the panel into the ALTER mode), then the CLOCK SET switch. At this time, the hours digit will flash. Hours may now be set by pressing and holding either the CLOCK UP or CLOCK DOWN switches on the auxiliary switch panel. Minutes are set by again pressing the CLOCK SET switch which will cause the minutes digits to flash. Minutes may now be set by pressing and holding either the CLOCK UP or CLOCK DOWN switches. The procedure is completed by pressing the CLOCK SET switch to set the time and put the panel back into the NORMAL mode. At any time during the setting operation, depressing the NORMAL/ALTERNATE key will negate the setting operation and return the panel to the NORMAL mode. The clock uses battery power in order to continue running when the engine is shutdown. Consequently, if the battery is disconnected from the truck system, the clock will require resetting.

Indicators And Warning Lights

Oil Pressure

A red warning lamp in the truck's overhead light bar will be illuminated when oil pressure is below the specified pressure threshold for the engine. The indicator is illuminated at engine start to provide a bulb check.

#227

Water Temp

A red warning lamp in the truck's overhead light bar will be illuminated when coolant temperature is greater than the specified threshold. The indicator is illuminated at engine start to provide a bulb check.

Check Status

This indicator on the panel will be illuminated when the electronic display diagnoses a fault in itself. The indicator is illuminated at engine start to provide a bulb check. The CHECK STATUS light becomes active when the display is intentionally placed in the diagnostic mode by pressing the NORMAL/ALTERNATE switch (to put the panel into ALTER mode) and then pressing the STATUS switch to display diagnostic codes.

Highbeam

The blue highbeam indicator is illuminated whenever the headlight highbeams are energized.

Turn Signals

Separate left and right turn signal indicators will be illuminated when either the right or left turn signal lamps are energized.

Diagnostics

To display diagnostics, first press NORMAL/ALTERNATE (to put the panel into the ALTER mode),and then press STATUS. The area that normally displays HRS/O.A.T./AVG SPD will now display diagnostic messages. Codes are shown as a three digit number preceeded by a lower case d and a dash (d-xxx). By pressing STATUS repeatedly, additional codes will be displayed until the list of faults is depleted (indicated by d----). The diagnostic list can be cleared from memory by pressing CLOCK SET when any diagnostic code is displayed in the area for diagnostics. Pressing CLOCK SET at any other time will not erase the stored diagnostics from memory. Diagnostic messages for the panel are shown in the table.

Diagnostic Code	Definition
d-134	Internal RAM test failure
d-135	NV RAM hard failure
d-136	NV RAM soft failure
d-137	Bad ROM LRC
d-143	A/D chip failure
d-144	A/D reference failure
d-145	Oil pressure data over-range
d-146	Oil pressure data under-range
d-151	Tachometer pulse input failure
d-152	Speedometer pulse input failure
d-153	O.A.T. data over-range
d-154	O.A.T. data under-range
d-155	Coolant temperature data over-range
d-156	Coolant temperature data under-range

Diagnostic codes aid in servicing your vehicle. If a code is displayed, notify your Kenworth Dealer.

Alarm Set Speed

This display is located at the upper right corner of the display panel. When the vehicle's road speed exceeds the preset limit, an audible electronic alarm will warn the driver that the set speed has been exceeded. The speed at which the alarm activates may be adjusted up or down by pressing either the ALARM UP or ALARM DOWN switches on the auxiliary control panel. The feature may be overriden by depressing and holding the ALARM UP switch until the set speed is greater than the actual road speed of the vehicle. When the speedometer is switched to indicate kilometers per hour, the alarm set speed will also be indicated in kilometers per hour.

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DDEC II
Advanced Electronic Diesel Control

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Detroit Diesel Allison Division
General Motors Corporation

DDEC II, ADVANCED ELECTRONIC DIESEL CONTROL

ABSTRACT

DDEC II (Detroit Diesel Electronic Control) is an advanced technology electronic fuel injection and control system for diesel engines. New technologies in microprocessor electronics are used, allowing a fuel-cooled engine mounted design.

The DDEC II design provides expanded capabilities with improved performance, and benefits in both cost and reliability. This system, using the new GMSCM (General Motors Single Chip Microprocessor), has increased computational speed for enhanced engine governing, on-chip functions for expanded diagnostics and communications, and I/O to meet current and future needs.

EEPROM is used in end-of-line programming of basic engine ratings and customer-selected options. Engine power derating and modification of vehicle application options are also provided. Industry standardized 9600 Baud serial data links provide two-way communications with vehicle displays, diagnostic equipment, and other vehicle systems.

BACKGROUND

Detroit Diesel Allison (DDA) introduced Detroit Diesel Electronic Control (DDEC) [1]* in September 1985, and became the first U.S. engine manufacturer to provide an electronic engine control system for the heavy duty diesel trucking industry. This system, based on the General Motors Custom Microprocessor (GMCM) chip set, controls fuel injection timing and quantity via electronic unit injectors (EUI). This two-box system includes a cab-mounted module containing the digital electronics and an engine-mounted, fuel-cooled module with the analog injector driver components. Sensors, monitoring critical engine operating parameters, provide signals to DDEC for the microprocessor calculations. In addition to electronic fuel control and speed governing, DDEC I provided self diagnostics, engine protection diagnostics and a wide selection of application options, such as cruise control and road speed governing.

The DDEC II development took advantage of advances in technology to integrate all control system electronics into a single engine-mounted, fuel-cooled electronic control module (ECM). Utilizing the General Motors Single Chip Microprocessor (GMSCM), it provides enhanced control system performance and additional control features as well as simplified OEM installation. This paper presents the main features of the DDEC II controller.

SYSTEM OVERVIEW

The major subsystems of DDEC II include the electronic unit injectors, the electronic control module, and the sensors (Figure 1). Fuel is delivered to the cylinders by the electronic unit injectors

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DDEC II has the capability of operating two separate serial data links. One of these communication nodes is connected to the J1708 general-purpose link for the primary purpose of transmitting sensor data to other modules within the vehicle (Figure 10). These modules may include electronic dashboard displays, vehicle management information systems, and electronic transmissions. In addition to sensor data, other

VEHICLE DATA COMMUNICATIONS

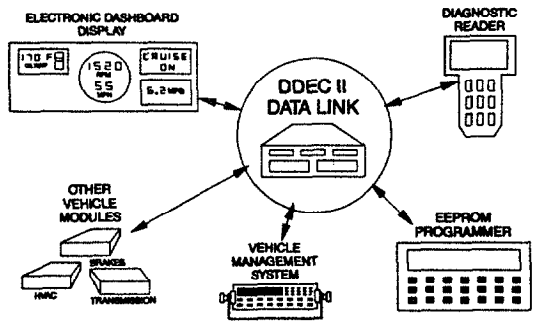


FIG. 10

parameters available from the DDEC II system include calculated engine fuel rate and total fuel consumption, total engine hours accumulated, and engine calibration identification.

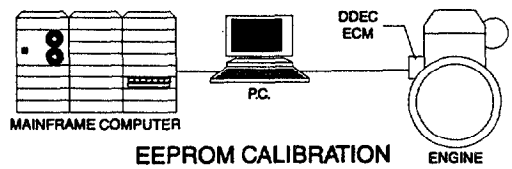
The general-purpose link is also used to transmit diagnostic information or perform diagnostic functions in response to requests received from external instrumentation. Requests for changes to feature and function calibration values stored in EEPROM are also received across the data link.

The second data link provided in DDEC II is used for special applications. One application is the control of a 12 or 16-cylinder DDA engine where two DDEC II ECM's are connected in a master/receiver configuration. Fuel control information is sent across the data link.

EEPROM

The DDEC II GMSCM microprocessor contains 2K bytes of EEPROM. This memory is programmed via the serial communication link with engine basic performance and certification data, as well as the data defining the customer-specified options. During engine assembly, just prior to final test, the DDEC II ECM is interfaced via the data link to the factory engine scheduling computer to program the EEPROM to the specific sales order for the engine, as shown in Figure 11. Security measures

EEPROM END-OF-LINE PROGRAMMING



EEPROM CALIBRATION

BASIC RATING
- BHP/RPM
- GOVERNOR FEATURES
  - LOW & HIGH IDLE
  - DROOP

CUSTOMER OPTIONS
- ENGINE PROTECTION (WARNING OR SHUTDOWN)
- ROAD SPEED/CRUISE CONTROL
  - MAX. SPEED
  - AXLE RATIO
  - TIRES REV/MILE
  - TRANSMISSION DATA
  - VEHICLE SPEED SENSOR
- POWER CONTROL
- SPECIAL APPLICATION FEATURES

FIG. 11

insure both the accuracy of the programming and the prevention of unauthorized access to these memory locations. A special feature will permit later reprogramming of the horsepower rating of the engine to a derated level by authorized DDA distributors.

Customer selected options, such as cruise control, road speed governing, engine protection shutdown and idle-timer shutdown can be reprogrammed using a hand-held diagnostic reader. Unauthorized programmed changes are protected by security passwords and an internal audit trail.

One area of the EEPROM is reserved for storage of data that changes during engine operation. This memory is used for the logging of accumulated engine operating hours, fuel consumption, diagnostic codes and other cumulative information. The memory storage is maintained when battery power is removed from the ECM. All of this information can be readily accessed via the serial communication link by the DDEC II diagnostic readers or other equipment capable of accessing the data link.

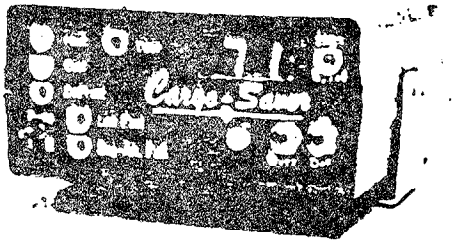
DIAGNOSTICS

The on-board diagnostics that were introduced with the DDEC I have been expanded and refined in DDEC II. These capabilities can be categorized into three areas: self diagnostics, engine system protection and engine performance diagnostics.

Self-diagnostics - The ECM continuously performs self-checks and monitors the other system components, including the injector solenoids, sensors and wiring. System diagnostic checks are made at ignition-on and continue throughout all engine operating modes. When a fault is detected and exists for more than two seconds, the ECM illuminates the dashboard 'CHECK ENGINE' light to alert the vehicle operator of the

Load Monitors

Cargo Saver load monitors feature easy-installation package and plug-in connector system. Cargo Saver II has rear door ajar



alarm and a defrost hang-up alarm monitored by LED and audible alarm, and features a non-flashing green LED readout.

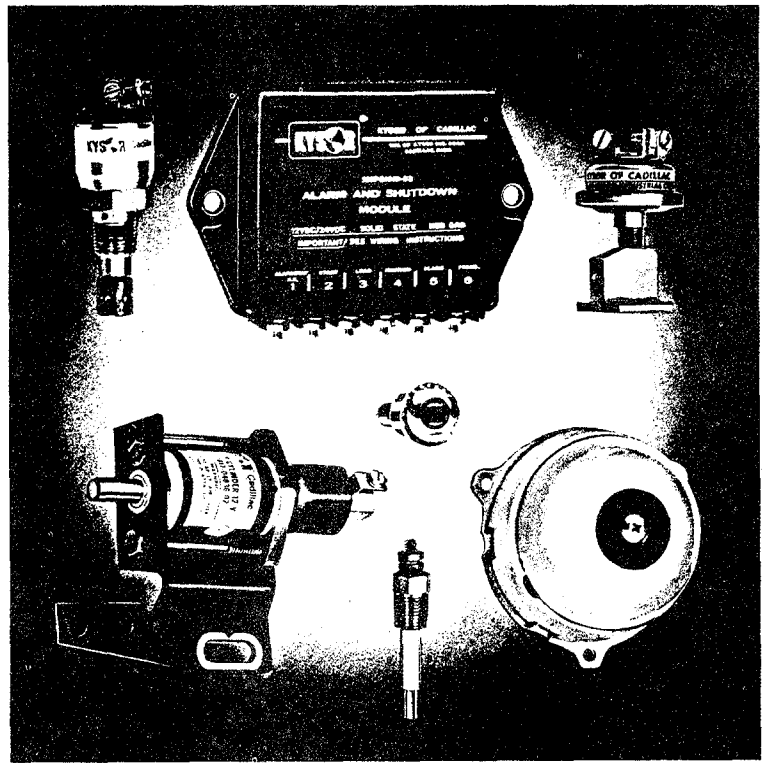
Cargo Saver III has all these features plus a programmable high/low set point to keep load within a specified temperature range. All features transmitted to driver if he is away from his rig within a ½- to 5-mile range. Monitors can be adapted to a variety of options, including produce probe or monitoring the rear unit in a set of double trailers.

Cargo-Saver, Inc.

● Circle 128 on Reader Action Card ●

Kysor Engine Protection Systems

Protecting A Major Investment



A truck engine is a major investment, and protecting it against damage and destruction just makes good sense.

Even with regular and expert maintenance programs, hoses can break, seals can rupture, and water pumps can fail. In addition, inaccurate gauges and driver inattention continue to be two of the most common causes of catastrophic engine failure. With engine replacement costs running as high as $15,000 and downtime costs escalating, an engine protection system is inexpensive insurance against costly damage to an engine in any kind of service.

That's why Kysor|Cadillac offers a series of simple but highly effective Alarm and Engine Shutdown Systems which help guard against catastrophic damage or loss of an expensive engine.

With a Kysor Engine Protection System, if a problem occurs, a driver is alerted by a warning light and/or audible alarm. For remote, stationary applications, the alarm could take the form of a high decibel air horn or whistle. All Kysor alarm systems can also be equipped with a Kysor engine shutdown device.

Audible and Visible Alarm Systems

Kysor audible and visible alarm systems are activated by any of the following conditions:

System 1: Low coolant level
System 2: Low oil pressure
High coolant temperature
System 3: Low coolant level
Low oil pressure
High coolant temperature

Engine Shutdown

In addition to audible and visual alarms, two systems come equipped with an engine shutdown capability when conditions become critical. These are:

System 1: Low oil pressure
High coolant temperature

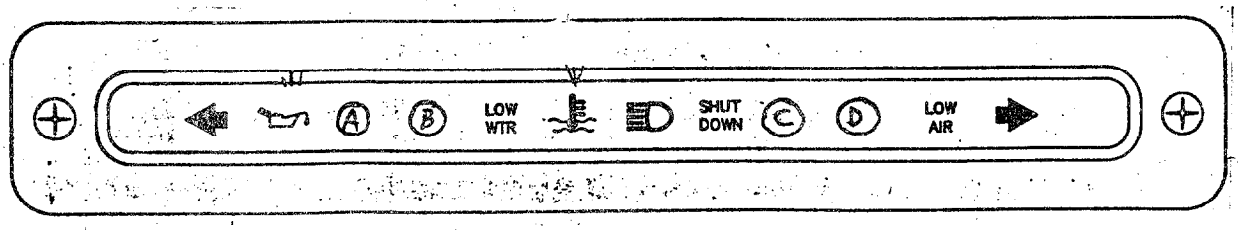
System 2: Low coolant level
Low oil pressure
High coolant temperature

There is a choice of engine shutdown systems which offer one time only or multiple restarts with 30 second engine operation. These systems are also available with manual shutdown controls and key switch shutdown.

Kysor Pre-wired Engine Protection kits offer the added convenience of speedier, simplified installation. These kits include a control module, wiring harness and all necessary hardware fittings. The color-coded harness cuts installation time from four hours to just 30 minutes on some vehicles.

Kysor|Cadillac is the world's leading supplier of reliable Engine Protection Systems for vehicle or other applications. Kysor systems are covered by a 100,000 mile warranty. Service assistance, if needed, is available for all Kysor Engine Protection Systems through our nationwide field service, OEM and distributor network.

UNDERSTANDING AND TROUBLESHOOTING THE FREIGHTLINER/KYSOR VEHICLE INSTRUMENTATION & PROTECTION (VIP) SYSTEM



DESCRIPTION

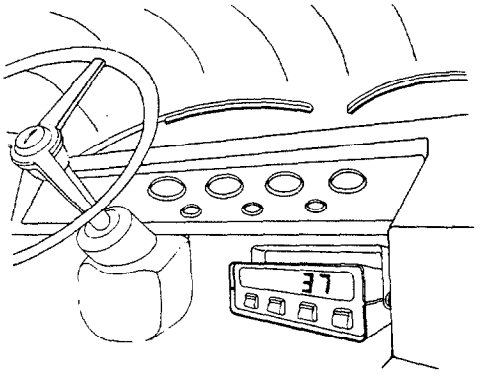
The VIP is a solid state instrument panel indicator cluster. Viewed from the driver's seat, the display is approximately 10 inches in width and 1.5 inches high. Behind the display is a box containing the components which penetrates about 3.5 inches behind the dash. The VIP is connected to the vehicle wiring harness with six Packard connectors. VIP performs operation and/or monitoring of several vehicle and engine functions. These functions can be broken into three groups for descriptive purposes:

1. ENGINE FUNCTIONS

VIP provides 3-way engine protection. That is, engine coolant temperature, oil pressure and coolant level are monitored. In the event of overheating, VIP activates the overheat symbol and the warning buzzer. (The actual temperature will vary with engine type and is programmed into VIP at the factory.) If overheating continues to critical levels, VIP will illuminate the "SHUT DOWN" display and simultaneously shut the engine down by removing voltage from the fuel control circuit. (Shutdown temperature varies with engine type and is programmed at the factory.) If oil pressure should be lost, VIP will activate the low oil pressure symbol and the warning buzzer. (Warning pressure varies with engine type and is determined by the set point of the warning switch.) If oil pressure drops to critical, VIP will illuminate the "SHUT DOWN" display and simultaneously shut the engine down. (Shut down pressure varies with engine type and is determined by the setpoint of the shut down switch.) If coolant should be lost, VIP activates the "LOW WTR" display and the buzzer. Some thirty seconds after the warning begins, VIP will illuminate "SHUT DOWN" and shut the engine down. HOWEVER, this feature (low coolant shutdown) may be turned on or off through a dip switch inside the VIP module. It may be set at the factory or in the field, depending on the customer's wishes. On all shutdown features, an automatic override is provided: if necessary to move the vehicle to a safe location after a shutdown, the operator need only to crank the engine; it will restart and run for approximately 30 seconds and then will be shut down again.

MODE – PRO IV & V

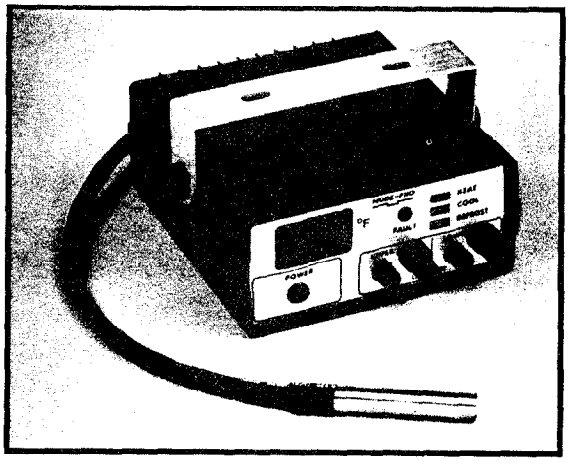
CAB MOUNTED TEMPERATURE MONITORS



The *MODE – PRO IV* and V are in cab temperature monitors with adjustable limits for upper and lower temperature. (Optional limits on *MODE – PRO IV.*) Should the load temperature exceed the limit settings, an alarm will sound alerting the operator to a temperature problem. An optional alarm contact is available for remote fault indication.

The *MODE – PRO* displays the refrigeration units operating modes; front panel indications are: heat, cool, defrost and a fault condition.

MODE – PRO IV

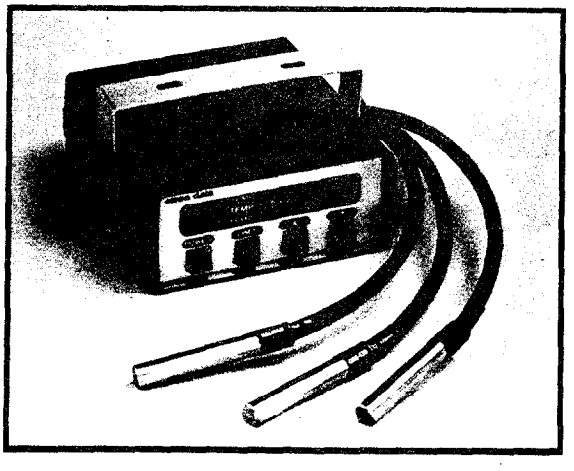


- Single probe temperature input.
- Temperature range -40° to 99° F.
- Refrigeration mode indication for Heat, Cool and Defrost.
- Fault condition indication.
- Multi-position mounting bracket.

OPTIONAL:

- Adjustable upper and lower temperature limit
  - Temperature limits remembered when power is removed.
  - Audible alarm if limits exceeded.
  - Adjustable time delay for alarm 2 - 60 minutes (for defrost override).
- Alarm contact.

MODE – PRO V



- Three temperature probe inputs.
- Automatically cycles through and displays each of the temperature probes.
- Adjustable upper and lower temperature limits for each probe input.
- Temperature limits remembered even when power is removed.
- Audible alarm if limits exceeded.
- Adjustable time delay for alarm, 2 - 99 minutes (for defrost override).
- Temperature range -40° to 150° F.
- Refrigeration mode indication for Heat, Cool and Defrost.
- Fault condition indication.

OPTIONAL:

- Alarm contact.

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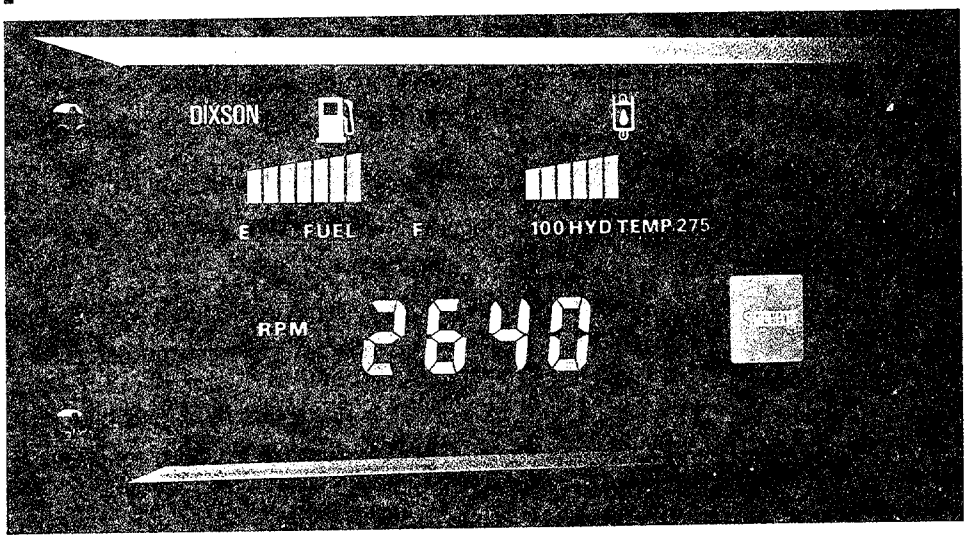
DIXSON, inc

HEAVY DUTY DIVISION

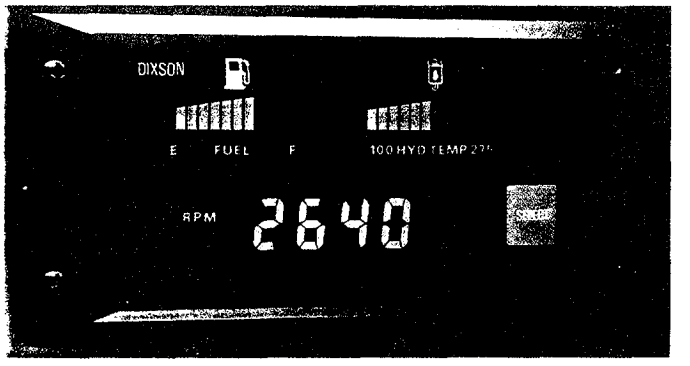
presents the



DB212 Digital/Bargraph
Engine Monitoring System

The Dixson state of the art EMS has found acceptance in a wide variety of applications. Its appeal includes the most commonly monitored engine functions, sensors and preset alarm points. We offer the fastest factory to installation availability in today's market place.

PART NUMBER
DB212-48365



The Dixson LCD Digital/Bargraph model DB212 features:

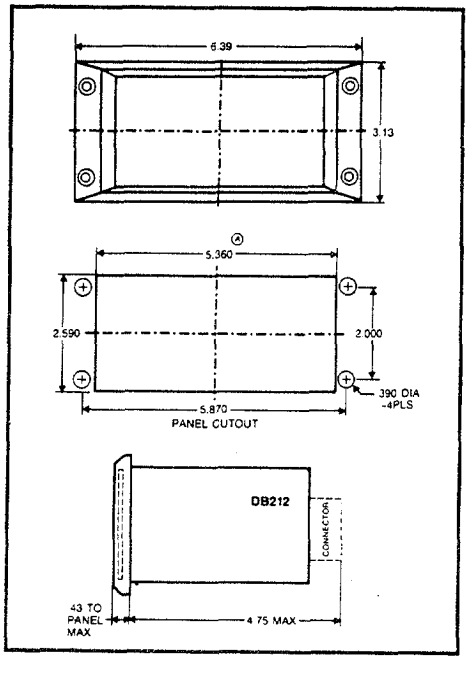
- 7 functions monitored (only as shown)
- 2 twelve segment bargraphs
- 5 function digital readout
- 1 controlled output line used to turn on an external warning device as specified below.

Bargraph displays:

- Fuel level: Lowest segment shown red, remaining are green. Alarm point at 8%. Bargraph flashes.
- Hydraulic oil temperature: 9 lowest segments are green, remaining 3 red. Alarm point at 210° F. Bargraph flashes, controlled output activates.

Digital display (select switch):

- Engine RPM: Field calibratable to sense 103, 111, 113, 118, 126, 136, 138, 142 or 156 flywheel teeth. Magnetic sensor driven.
- Hours: Activated when oil pressure is greater than 2 PSI. Memory retention with battery disconnected.
- Oil pressure: Alarm point at 5 PSI or lower. Annunciator flashes, controlled output activates.
- Water temperature: Alarm point at 210° F. Annunciator flashes, controlled output activates.
- Volts: Alarm point at 10.4 V. Annunciator flashes, controlled output activates



Sensors:

Please contact factory for recommended sensors.

General Specifications:

Display

Standard	Liquid Crystal Display (LCD)

Electrical

Supply Voltage	12VDC-operating range 11V min. to 18V max.
Transients	Exceeds SAE J1399
Polarity	Reverse polarity protected
Start Protection	24V max. for 30 minutes
Lighting	12V bulb = GE194

Environmental

Temperature	−40° to +70°C operating −40° to +85°C storage
	Referenced temperatures are for standard configurations.
Humidity	95% RH @ 38°C
Shock & Vibration	Meets SAE J1399
	Dust and splash protected

Mechanical

Bezel	Phenylene Oxide
Case	Glass filled Phenylene Oxide standard
Connector	AMP "MATE-N-LOK" standard
Dimensions	See drawings
Front Panel Protection	Polycarbonate overlay
Installation	Front mountable
Mounting Hardware	4 WELLNUTS and 4 machine screws (#10 × 32).
Panel Cutout	5.36" × 2.59"

For more information about Dixson solid state instrumentation contact:

DIXSON, inc

HEAVY DUTY DIVISION
P.O. Box 1449
Grand Junction, Colorado 81502
(303) 242-8863

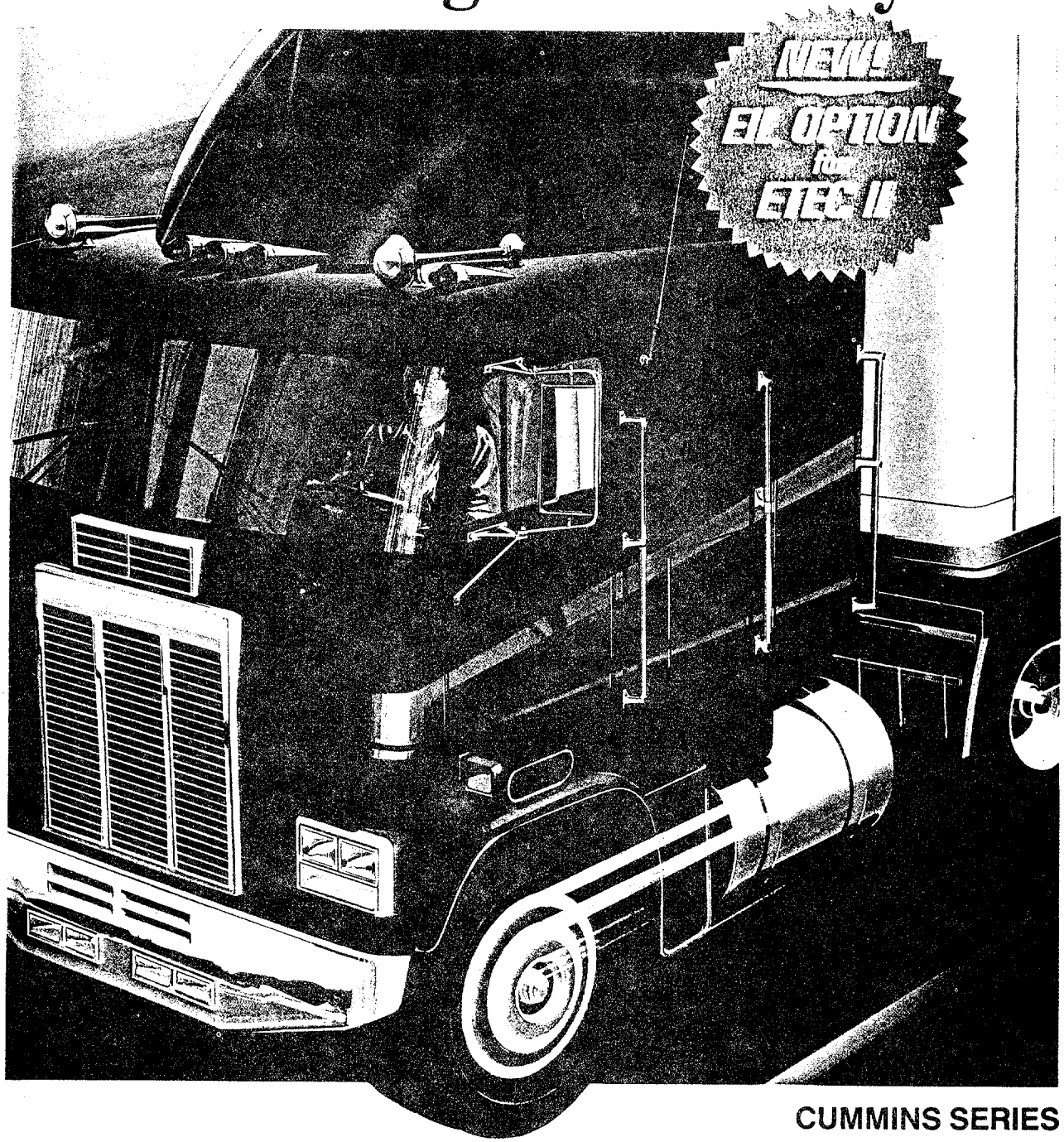
Printed in USA
P/N 071-34645 10/86

#255

TRW

ETEC II™

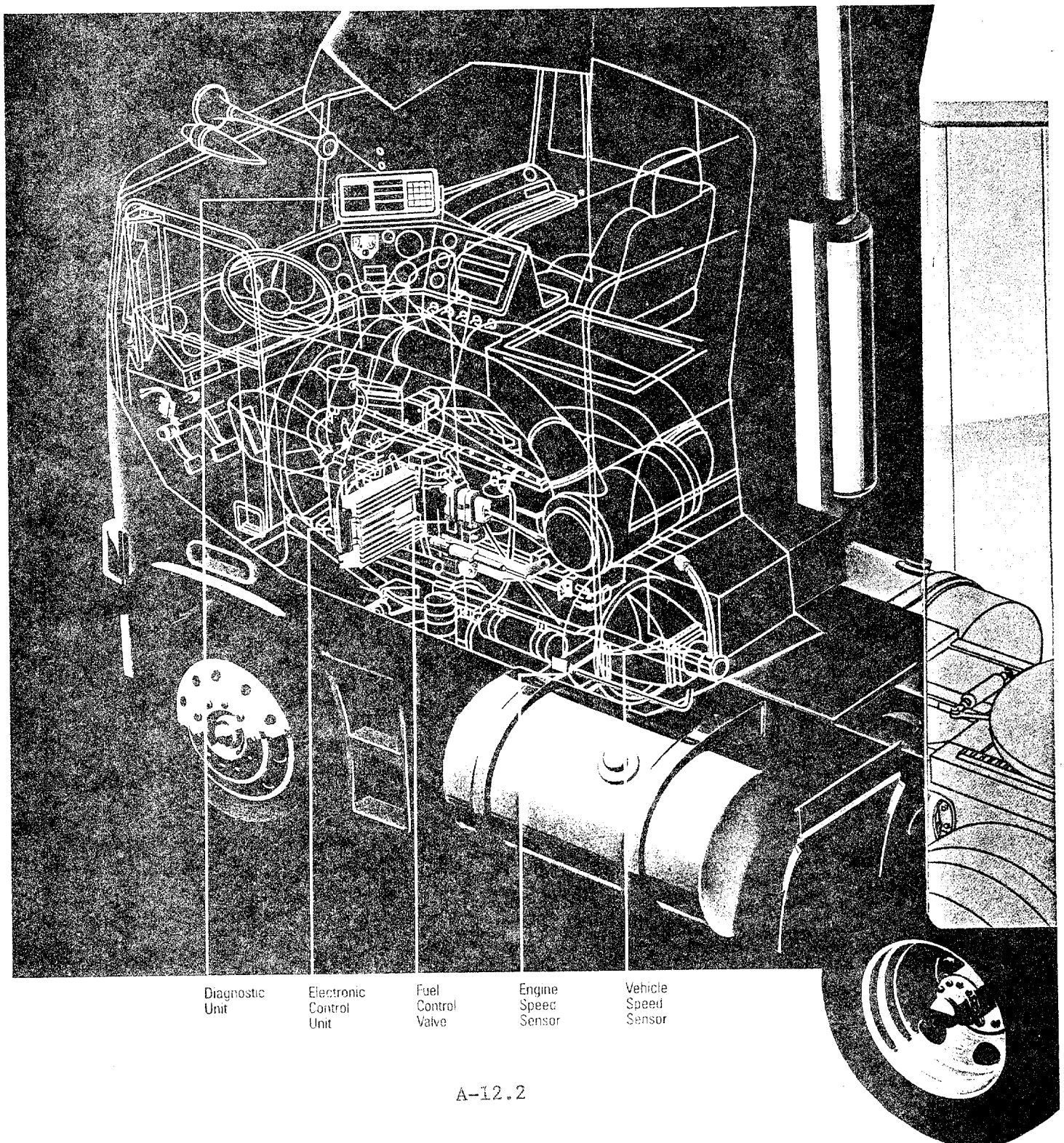
Electronic Engine Control System



CUMMINS SERIES

ETEC II Electronic Engine Control System

- **For Fleet Operation:**
  Immediate payback through improved fuel economy and lower truck maintenance costs.
- **For the Driver:**
  Less fatigue with cruise control and speed control.



Diagnostic Unit
Electronic Control Unit
Fuel Control Valve
Engine Speed Sensor
Vehicle Speed Sensor

The ETEC II System from TRW is an electronic engine control system. It governs engine performance precisely, providing both fleets and drivers with improved fuel economy and driving ease at a new level of proven reliability.

The Competitive Edge:

With the ETEC II System, the "gear fast/run slow" drivetrain concept is now a reality in day-to-day fleet operations. Under this concept, the use of high-ratio gears permits the engine to be run at a lower rpm at cruising speeds. When specified with the ETEC II System, the vehicle can be operated within its optimal fuel economy range. Now, the fleet manager can select the engine and vehicle speed limits which he feels are the best trade-off of speeds and fuel economy.

Computer Control:

The "brain" of the ETEC II System is an on-board electronic control unit. This microprocessor-based control unit can be programmed by the fleet manager to meet his specific vehicle application requirements. Once programmed, the system continuously monitors engine and vehicle speed operation, and automatically controls the speeds within prescribed limits. All this is done while the truck is operating, achieving more fuel efficient engine performance.

Features of the ETEC II System:

Saves Fuel–Using the ETEC II System's Cruise Control mode and the "gear-fast/run slow" concept, documented fleet experience has shown that the ETEC II System can produce actual fuel savings of 5%-25%.

For example, given a typical vehicle annual travel of approximately 100,000 miles, the ETEC II System can save the fleet $1500.00 or more annually* per vehicle. Some customers have shown savings of more than $5000.00 annually per vehicle.

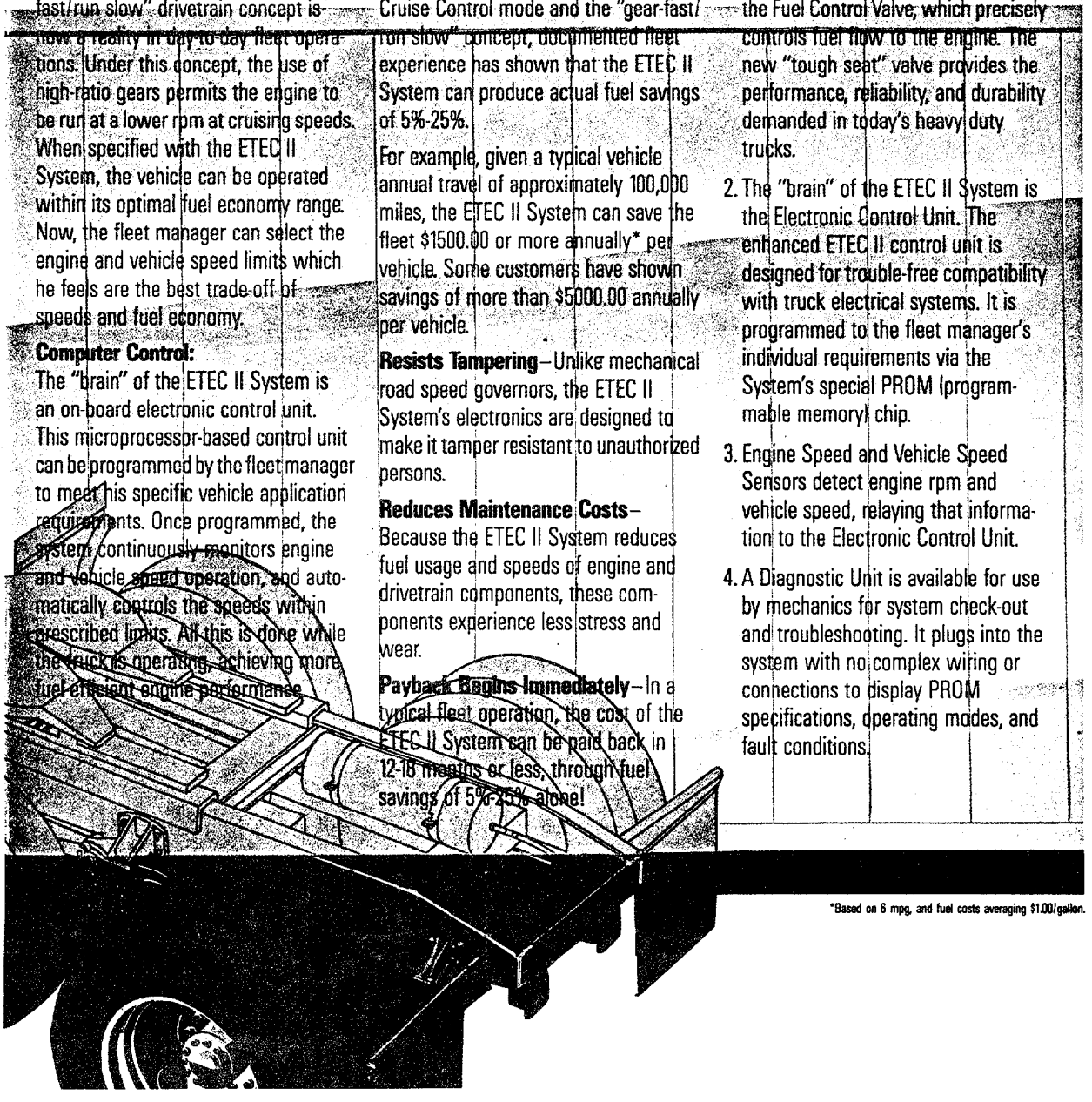
Resists Tampering–Unlike mechanical road speed governors, the ETEC II System's electronics are designed to make it tamper resistant to unauthorized persons.

Reduces Maintenance Costs–Because the ETEC II System reduces fuel usage and speeds of engine and drivetrain components, these components experience less stress and wear.

Payback Begins Immediately–In a typical fleet operation, the cost of the ETEC II System can be paid back in 12-18 months or less, through fuel savings of 5%-25% alone!

System Components:

1. The "heart" of the ETEC II System is the Fuel Control Valve, which precisely controls fuel flow to the engine. The new "tough seat" valve provides the performance, reliability, and durability demanded in today's heavy duty trucks.
2. The "brain" of the ETEC II System is the Electronic Control Unit. The enhanced ETEC II control unit is designed for trouble-free compatibility with truck electrical systems. It is programmed to the fleet manager's individual requirements via the System's special PROM (programmable memory) chip.
3. Engine Speed and Vehicle Speed Sensors detect engine rpm and vehicle speed, relaying that information to the Electronic Control Unit.
4. A Diagnostic Unit is available for use by mechanics for system check-out and troubleshooting. It plugs into the system with no complex wiring or connections to display PROM specifications, operating modes, and fault conditions.



*Based on 6 mpg, and fuel costs averaging $1.00/gallon.

HIGH COOLANT TEMPERATURE. This light signals that the engine shut down due to excessive coolant temperature. Check cooling system. If flashing, coolant temperature sensor is defective.

LOW OIL PRESSURE. This indicator tells you that the engine has shut down due to low oil pressure.

CHECK GLOW PLUGS. Lights up if one or more plugs are defective. Glow Plug switch must be held in the GLOW position for a minimum of 15 seconds to detect defective glow plug(s) in manual mode.

Digital readout code reference.

Several other operating modes can be displayed:

Display Message	Description
-dF-	Indicates unit is operating in Defrost. This message can be overridden by any keypad function.
PPPP	Indicates unit is operating in Pre-trip mode. This display can be overridden by any keypad function.

In addition, the LCD also displays specific unit malfunctions to guide troubleshooting. Diagnostic messages are:

Display Message	Description
-SP-	Indicates a valid setpoint has not been entered. Unit cannot be started until a valid setpoint has been entered.
Err. 1 (during self-test) Err. 2 Err. 3	Indicates processor logic errors. The processor is non-functional and must be replaced.
EEEE	Indicates alternate probe is not present or is defective.
96 (flashing)*	On single-probe units, probe has failed open. On dual-probe units, both probes have failed open.
100 (flashing)*	On single-probe units, probe has failed closed (shorted). On dual-probe units, both probes have failed closed.

* When probe failure occurs, COOL LED will also flash.

-Lb-	Indicates a low battery condition (below 10 volts).
-Hb-	Indicates a high battery or over-voltage condition (above 17 volts).

Unit will shut down if voltage is below 10 volts or above 17 volts.

Light bar. A trailer-mounted light bar is supplied with the microprocessor controller. The light bar displays unit operation for Cool, Heat, and Defrost. It also indicates Auto Start/Stop operation, Unit Fault, or Temperature Out-Of-Range conditions.

The light bar allows the driver to instantly monitor these basic functions by simply looking in his left-side mirror.

A-13.1

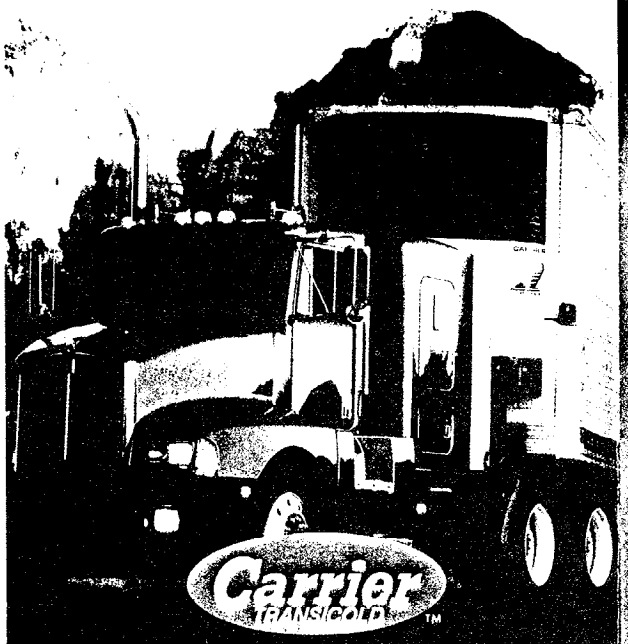
Need help? Just ask.

This touchpad, as well as the entire control system, has been designed with you in mind. It makes it easier than ever to set temperature and monitor all unit functions.

If you have difficulty using the touchpad or questions about the system, call our toll-free service hotline:

1-800-448-1661

In New York state, Canada, and Mexico, call collect: 315-432-4212



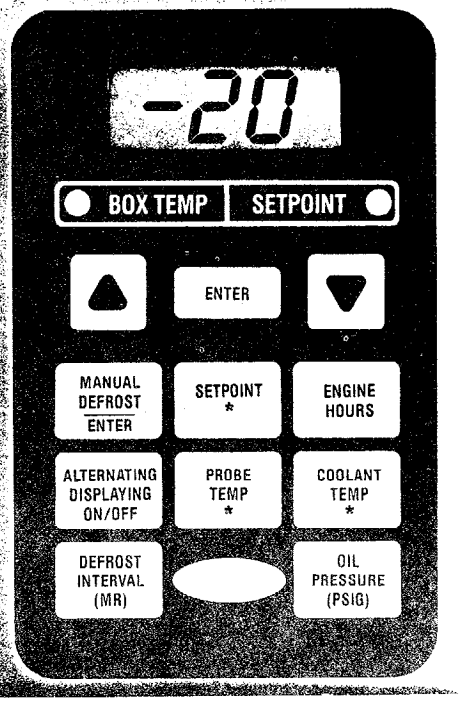
The Advantage You've Been Looking For.

Carrier Transicold Division
Carrier Corporation
P. O. Box 4805
Syracuse, NY 13221

Printed in U.S.A. 0887
Form No. 62-02182

UNITED TECHNOLOGIES CARRIER TRANSICOLD

Here's all you need to operate our digital temperature control system.



#258

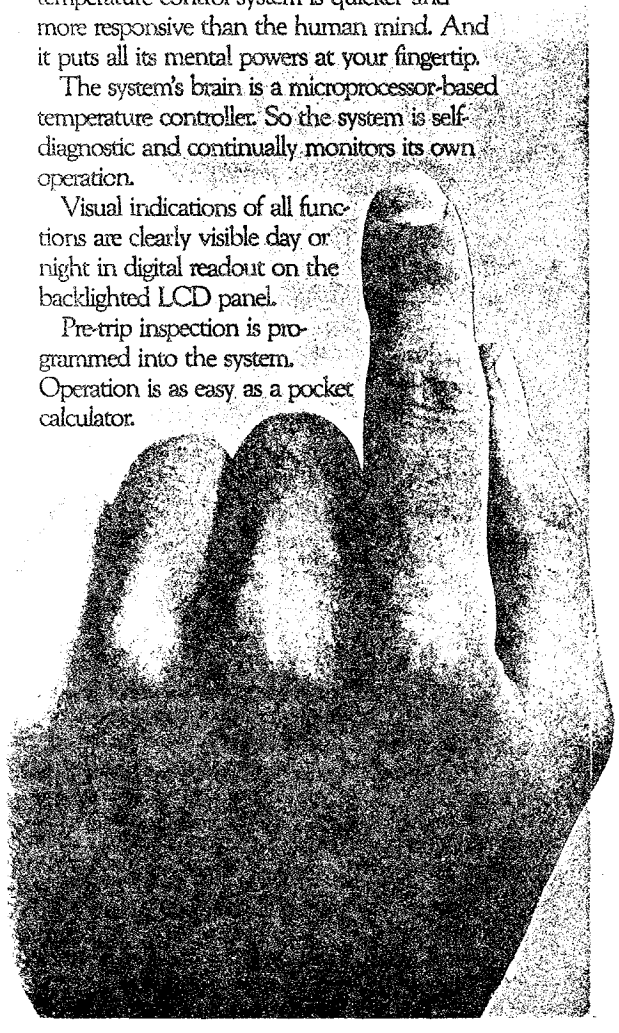
A single digit.

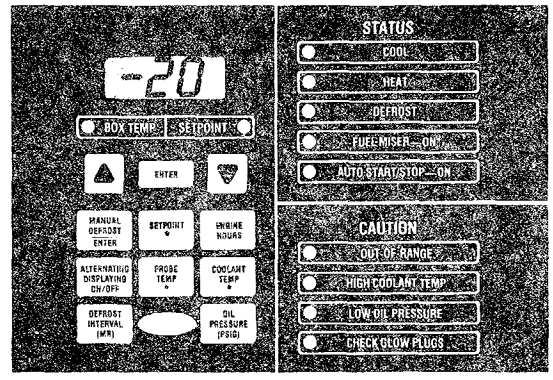
The exclusive Carrier Transicold digital temperature control system is quicker and more responsive than the human mind. And it puts all its mental powers at your fingertip.

The system's brain is a microprocessor-based temperature controller. So the system is self-diagnostic and continually monitors its own operation.

Visual indications of all functions are clearly visible day or night in digital readout on the backlighted LCD panel.

Pre-trip inspection is programmed into the system. Operation is as easy as a pocket calculator.





This keypad keeps you in touch.

The control system becomes fully operational immediately on unit power-up.

Here's step-by-step instruction for operating all keypad functions:

SETPOINT. Used to display or change setpoint temperature.

To check the current setpoint, press the SETPOINT key. The current setpoint will be displayed. If no other keys are pressed within five seconds, the display will revert to the current box temperature.

To change setpoint, press the SETPOINT key. Then use the Up/Down arrows to adjust the setpoint to the desired temperature. Press the ENTER key to enter the new setting into memory. For your own peace of mind, doublecheck the new setpoint after a change by letting the display revert back to displaying box temperature, then pressing the SETPOINT key.

NOTE: When changing the setpoint, always remember to ENTER the new setpoint.

DEFROST INTERVAL. Used to display or change defrost time interval.

To check the current defrost interval, press the DEFROST INTERVAL key and the current defrost interval will be displayed. Again, the display will automatically revert to displaying box temperature if no other keys are pressed after five seconds.

To change defrost interval, press the DEFROST INTERVAL key. Then use the Up/Down arrows to adjust the defrost interval to the desired setting. Press the ENTER key to enter the new setting into memory.

NOTE: When changing the defrost interval, always remember to ENTER the new defrost interval.

ENGINE HOURS. Displays cumulative engine operating hours. Press the ENGINE HOURS key for a current reading of diesel hours.

To display cumulative standby operating hours on Diesel/Electric units, press the ENGINE HOURS and ENTER keys simultaneously.

COOLANT TEMPERATURE. Displays engine coolant temperature. Simply press the COOLANT TEMPERATURE key to read temperature.

OIL PRESSURE. Displays engine oil pressure. Check engine oil pressure by pressing the OIL PRESSURE key. Oil pressure should be 40-60 PSIG in high speed.

PROBE TEMPERATURE. Displays active (controlling) probe temperature. Simply press the PROBE TEMPERATURE key. On units equipped with an optional second probe, press the PROBE TEMPERATURE and ENTER keys simultaneously to display the inactive (non-controlling) probe temperature. If the unit is not equipped with a second probe or the second probe is defective, EEEE will be displayed.

MANUAL DEFROST. To initiate a manual defrost, press the MANUAL DEFROST and ENTER keys simultaneously.

NOTE: The Defrost Termination thermostat must be closed to initiate a defrost.

ALTERNATING DISPLAY. Alternately displays box temperature and setpoint temperature at three-second intervals. Press the ALTERNATING DISPLAY key. To cancel Alternating Display, press keypad again.

Status lights give you an instant status report.

This feature gives you a complete "status report" of unit operation at a glance.

COOL. If the COOL light is on, the unit is operating in the Cool mode. If flashing, temperature probe is defective.

HEAT. If the HEAT light is on, the unit is operating in the Heat mode.

DEFROST. Indicates that the unit is operating in the Defrost mode. During Defrost, both HEAT and DEFROST lights are illuminated. If the DEFROST light is flashing, a defrost fault has been detected and unit is operating on its defrost override timer. Check defrost system.

FUEL MISER-ON. This light tells you when the unit is operating in the Fuel-Saving mode.

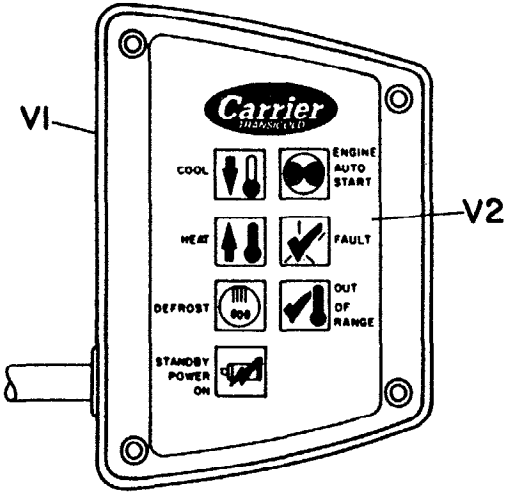
AUTO START/STOP-ON. If the AUTO START/STOP-ON light is on, the unit is operating in the Auto Start/Stop mode. If flashing, engine starting fault has been detected. Check starting system.

Caution lights speed troubleshooting and repair.

This feature lets you pinpoint problems, to guide troubleshooting and service faster and easier than ever.

OUT-OF-RANGE. The OUT-OF-RANGE light indicates that the active probe temperature is beyond the safe range of ±6°F of setpoint. It is normal for the OUT-OF-RANGE light to be on before an in-range condition is reached (such as during pulldown). If flashing, active probe temperature has been beyond the safe range of ±6°F of setpoint for 15 minutes after the unit was initially in-range. The OUT-OF-RANGE light on the remote light bar only lights up for this condition. For setpoints in the frozen range (less than 10°F), the unit is only considered out-of-range for temperatures 6°F or more above setpoint.

GROUP V - LIGHT BAR

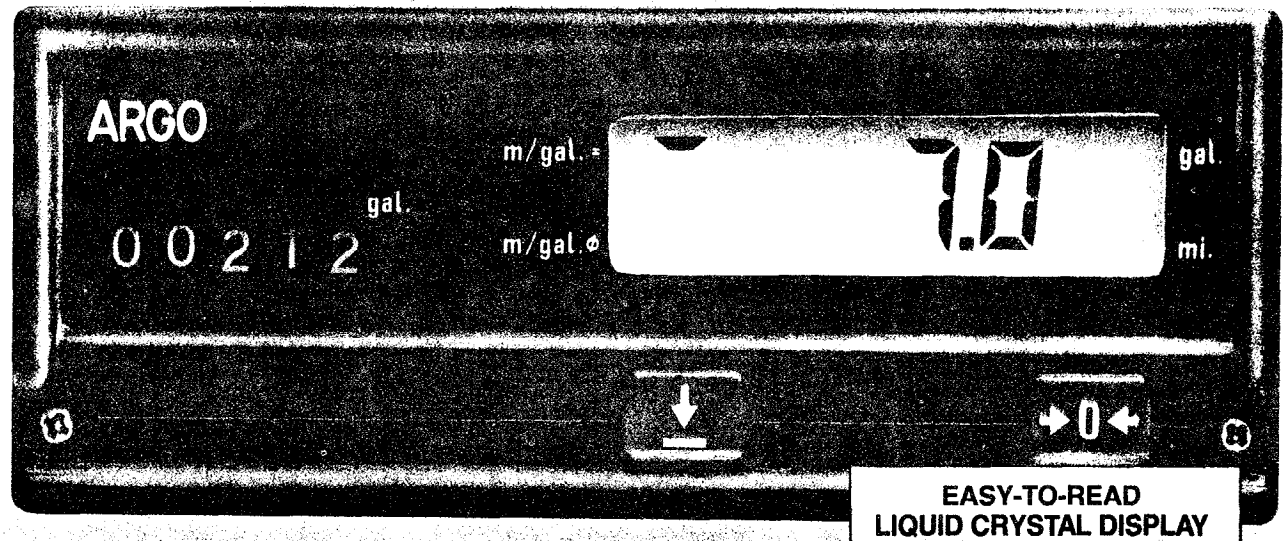


V1	76-50001-00	Kit, Light Bar - Includes:	1
V2	22-01465-50	Decal	1
NS	68-11009-00	Bracket, Mounting (NSI)	1

ARGO

EDM

ELECTRONIC DIESEL FUEL MONITOR



DISPLAYS

- Continuous MPG
- Average MPG since last trip or reset
- Total gallons per trip, per day or week
- Distance traveled since last reset

EASY-TO-READ LIQUID CRYSTAL DISPLAY

FLEET TESTED AND PROVEN

50,000 IN USE THROUGHOUT THE WORLD

- **Continuous MPG readout makes drivers more fuel conscious, encourages more economical driving**
- **Helps reduce maintenance costs and prolong vehicle life through more professional vehicle handling**
- **Can be used as a stand alone system or connected to an Argo tachograph or FMS on board computer to provide info about each driver and vehicle**
- **Accurate to ±2%**
- **Use as a training tool—shows driver effect of load, downshift and upshift on MPG.**

A-14.1

#260

EDM – a new management tool to help drivers operate more economically

Now each of your drivers can have the information he needs to achieve higher MPG.

The Argo EDM lets a driver display any of four functions at the push of a button, and use the info to improve his driving pattern.

Functions include continuous mpg…average mpg for the day or week …total gallons used since the last reset…and distance driven since the last reset.

With this information in front of him, a driver can monitor fuel consumption moment by moment on EDM's easy-to-read liquid crystal display.

The data helps you reduce fuel waste, parts wear and maintenance costs through more disciplined vehicle handling. And it provides you with objective hard copy information about each vehicle and each driver by connecting the system to the Argo FMS on board computer or Argo tachographs.

A-14.2

HOW EDM WORKS

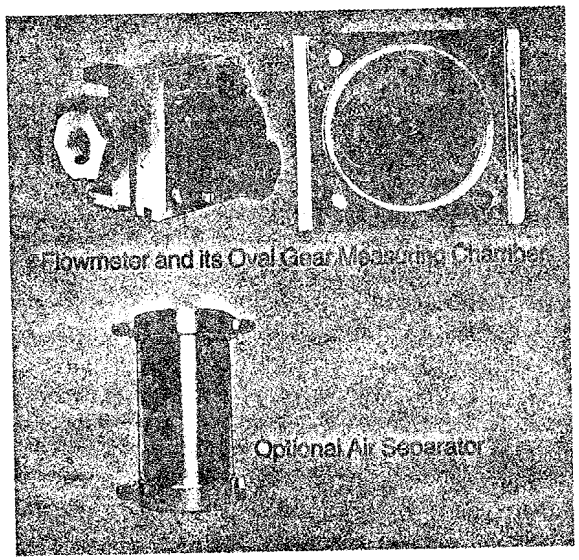
Fuel flows from the fuel tank to the fuel filter. The Argo flowmeter measures fuel flowing through the line and sends pulses corresponding to the amount of fuel used through a junction box. A vehicle speed sensor sends speed signals to the junction box.

The fuel and distance signals are transmitted to the display and memory unit or to the Argo FMS on board computer or Argo tachograph to be displayed and/or recorded.

Meanwhile the fuel continues to flow from the fuel meter to the air separator. The air separator (used for some engines) is used as a reservoir for return fuel, where air is separated from the fuel. Excess return fuel from the engine, which is used to lubricate and cool the engine, flows to the system's air separator. Excess air bubbles in the fuel are vented out through the air separator.

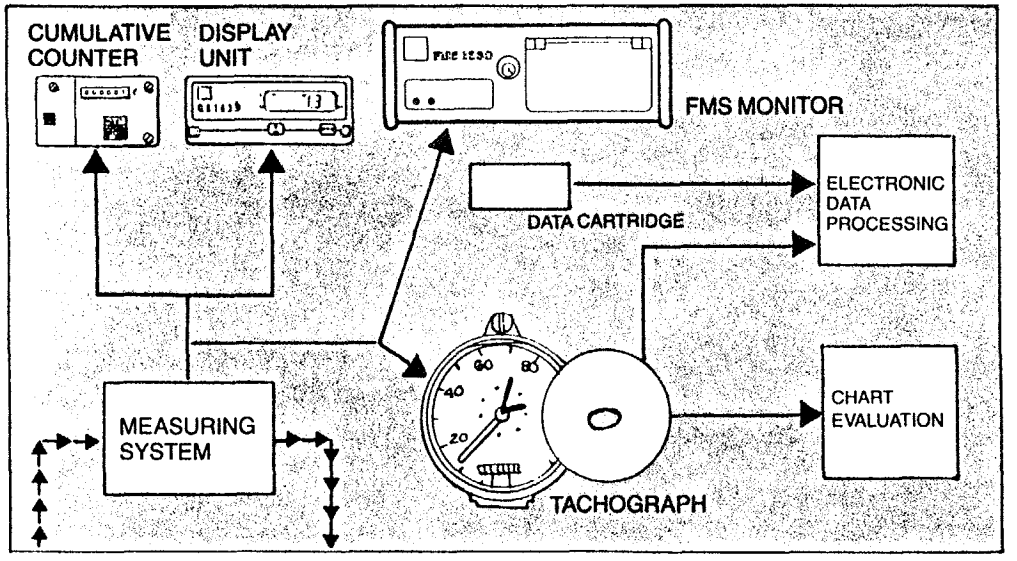
The check valve of the system makes certain that the fuel flows through the measuring device only once. Returned fuel is not measured again.

SYSTEM COMPONENTS



#260

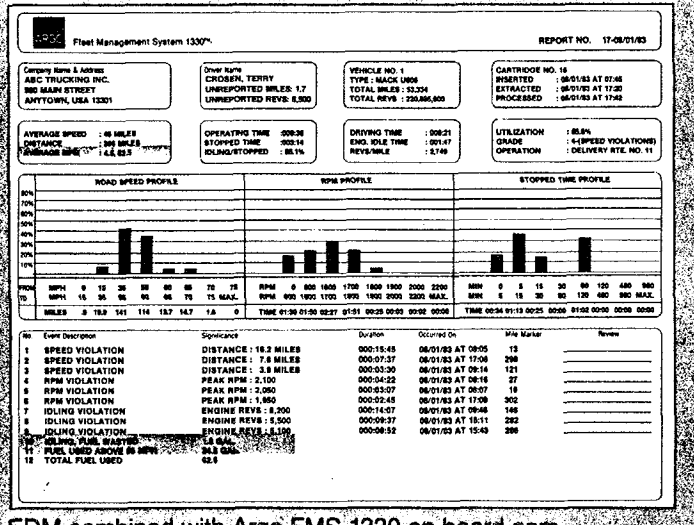
INFORMATION FLOW FROM **EDM** TO FMS ON BOARD COMPUTER OR TACHOGRAPH



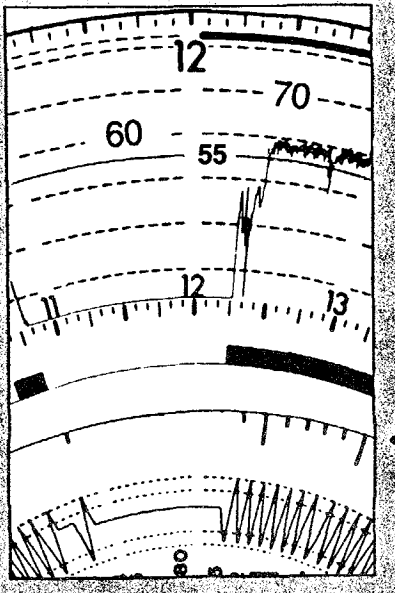
FOUR WAYS **EDM** HELPS YOU OPERATE MORE EFFICIENTLY

1. With Display Unit as a stand alone driver's aid.
2. With the Display Unit as a driver's aid, and connected to the Argo FMS on-board computer or tachograph to provide hard copy management information.
3. With cumulative counter to record total gallons of fuel consumed since installation, and connected to the Argo FMS on-board computer or tachograph to document fuel consumption on a hard copy report.
4. Connected directly to the Argo FMS on-board computer or tachograph to record fuel consumption information on the trip report or tach chart.

USE THESE MANAGEMENT REPORTS TO HELP REDUCE YOUR FUEL BILL

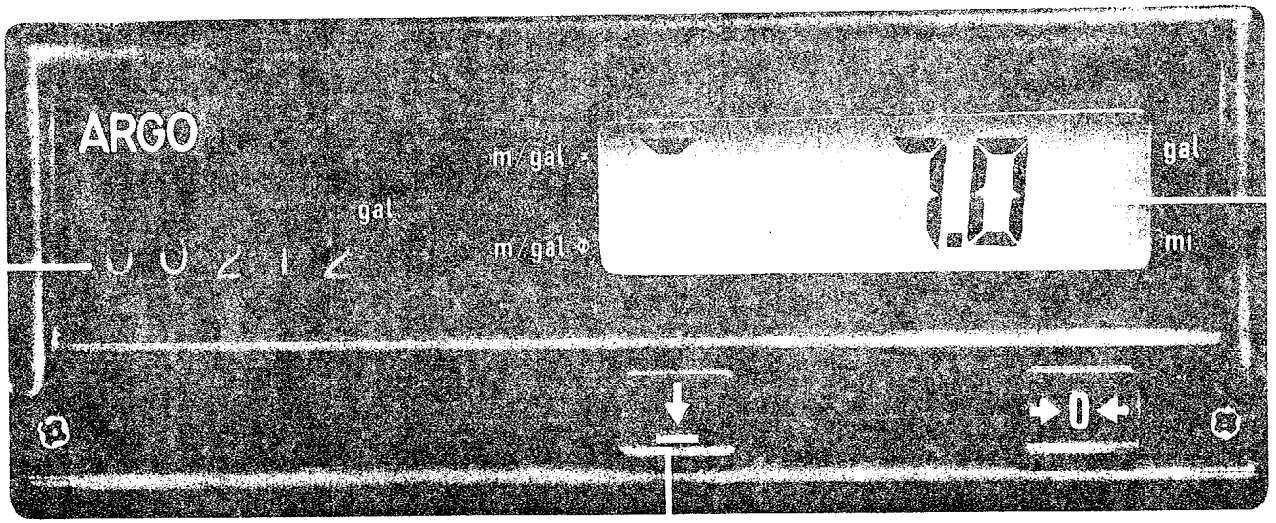


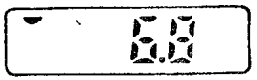
EDM combined with Argo FMS 1330 on board computer records average MPG and total gallons of fuel consumed on hard copy printout.



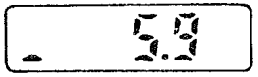
EDM combined with Argo tachographs records fuel consumption in gallons on the chart together with speed and/or engine rpm.

HOW EDM OPERATES TO MAKE YOUR DRIVERS MORE FUEL CONSCIOUS





INSTANTANEOUS MPG. Shows driver his MPG at a particular moment.



AVERAGE MPG. LCD readout shows average MPG.

TOTAL GALLONS. Gives driver a picture of how many gallons of fuel he's used since the last reset.

TOTAL MILES. A driver can see how many miles he's driven since the last reset.

Argo Instruments, Inc.
1013 Fort Collier Rd., Box 2997, Winchester, VA 22601 • 703-665-0200

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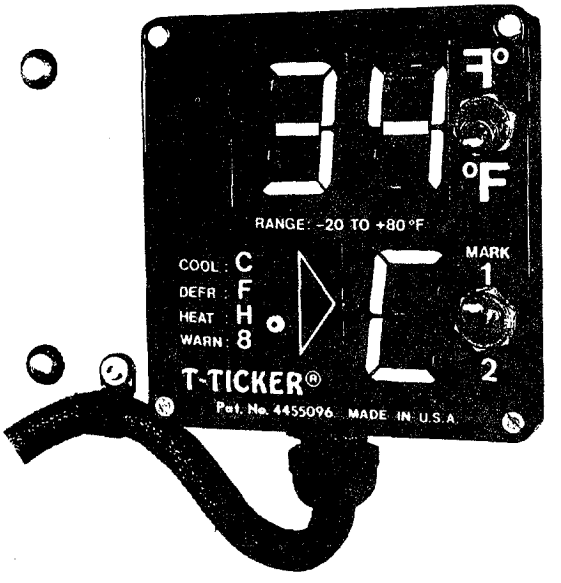
A-14.4

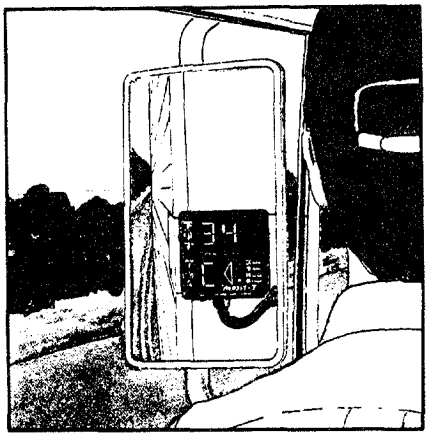
#260

T-TICKER® PROTECTION



The BRANDSTEDT T-TICKER® offers *PROTECTION* for your temperature sensitive cargo. The T-TICKER® eliminates the cost of losing a load and the increased insurance rates incurred. The T-TICKER® provides temperature information, status of refrigeration and visual warning of a malfunctioning reefer unit at just a glance. The T-TICKER® is being used by hundreds of fleets and has proven to be reliable and dependable *Protection* for your cargo and profits.

- Easily mounts on corner edge of truck or trailer.
- Temperature sensing probe inside the trailer or truck measures present temperature for display on monitor.
- Face is strong, 1/8" Lexan. Break and scratch resistant.
- Large, easy to read digits/letters illuminated for night viewing.
- Fluorescent yellow display for easy reading, won't interfere with night driving.
- Micro-processor controlled, self-calibrated, electro/magnetic display.
- Toggle switch reverses display so it can be read in your side mirror.
- Probe selector switch (model 40-342 only).
- Mode read-out indicates whether refrigeration unit is C – cooling, H – heating, F – defrosting. Flashing 8-warning of unit mode malfunction.



The T-TICKER® is the only digital temperature monitor using micro processor controlled calibrated electromagnetic displays. The T-TICKER® is time proven in all weather conditions. The rugged 100% non-corrosive construction makes T-TICKER® impervious to weather and washing. The vibration proof micro computer never needs recalibration and we back it up with a 2-year warranty.

Yes, I am interested in knowing more about Brandstedt Controls Corporation

☐ T-TICKER® ☐ T-MACS® ☐ Both *(Please check the appropriate box)*

☐ Please call me at the number below ☐ Please send me additional literature

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ **STATE**_____ **ZIP**_____

TELEPHONE (**)**_____ **Ext.**_____

COMPANY DATA
☐ Dealer
☐ Fleet

Fleet Size
☐ 1-25
☐ 26-50
☐ 51-100
☐ 101 plus

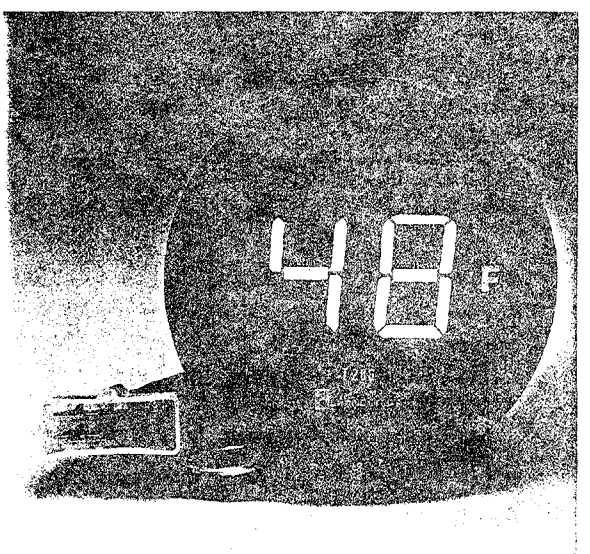
Type
☐ Refrigerated Trucks
☐ Refrigerated Trailers
☐ Refrigerated Containers

BRANDSTEDT CONTROLS CORPORATION 2730 S.W. 3rd Avenue, Miami, Florida 33129-2237 • (305) 856-8500 • (800) 426-5488

HIGH VISIBILITY DIGITAL DISPLAY

Nobody has a brighter, easier to read temperature/mode display. Even if your trucks are across the yard or your containers are stacked three high, Brandstedt's high visibility display overcomes distance and direct sunlight, and is easily seen at night.

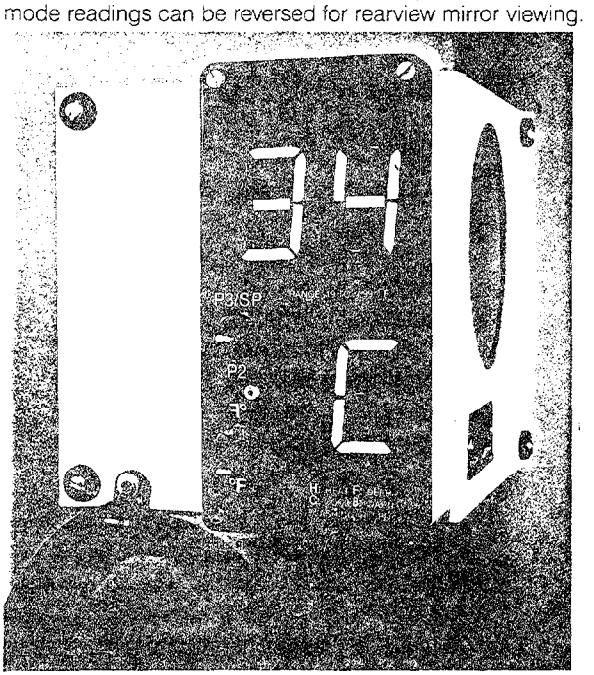
T-286. This round display is a computerized digital temperature monitor easily mounted on a container or trailer. This high visibility monitor can provide temperature readings at up to three probe locations.



T-286

DIAM: 4.75 INCHES
DEPTH: 2.0 INCHES
WT: 1 POUND

T-386. This computerized digital temperature monitor combines all of the features of the T-286 with a digitally displayed mode indicator that displays high speed cooling, defrost, heat and sensor failures. Both temperature and mode readings can be reversed for rearview mirror viewing.



T-386

H: 6.3 INCHES
W: 3.15 INCHES
D: 2.36 INCHES
WT: 2.25 POUNDS

Both display units are constructed to be completely weatherproof, non-corrosive and able to withstand high impact. Brandstedt combines highly reliable electro-mechanical displays with computerized, solid state drive circuitry. Our displays have been proven in thousands of installations. They offer high visibility in direct sunlight and no distracting glare at night while demanding a very low power requirement of about 1/10 amp.

Brandstedt's PRIMARY TECHNOLOGY offers the best of proven mechanical and solid state design which when combined provides the highest reliability.

COMPELLING REASONS

BILLIONS OF DOLLARS ARE LOST ANNUALLY DUE TO TEMPERATURE-SENSITIVE CARGO DAMAGE.

Move any perishable product through the distribution system and there is bound to be a critical sensitivity to temperature change.

THE USDA, NASA AND THE DEFENSE DEPARTMENT ARE TOUGHENING THEIR STANDARDS.

The demand for accurate temperature control and recording systems is becoming mandatory.

TODAY'S HIGH STANDARDS WILL MORE THAN EVER REQUIRE CONSTANT ON BOARD MONITORING.

There is now a system specifically designed to provide quick, clear and accurate readings — readings later confirmed by a printout of data that was stored in the solid state memory unit during the trip.

INTRODUCING T-MACS AND CARGOCARE:

T-MACS is the first on board truck, trailer or container mounted time/temperature monitoring and control system that also records temperature at specific time intervals and accumulates this data to be retrieved for future analysis.

CARGOCARE is Brandstedt's software package that works in conjunction with the T-MACS recorders to add computing, sorting and reporting power to provide a variety of customized management reports.

LOOK AT THE FEATURES AND BENEFITS

- PROVIDES VISIBLE TEMPERATURE/HUMIDITY DISPLAY — Take instant corrective action.
- PROVIDES VISUAL WARNING OF REEFER UNIT MALFUNCTION — Know exactly when you have a problem.
- REAL TIME CLOCK — All recordings are made at actual time of occurrence.
- RECORDER HAS ID NUMBER — Can match recorder number to trailer/container number to create management reports and data bases that are unit specific.
- CALIBRATION IS PRE SET AT FACTORY — Can't be changed to distort actual recordings. Each trip begins with automatic calibration.
- MEMORY CAN'T BE CLEARED WITHOUT EXTRACTING ALL DATA — Valuable information won't be lost due to accident or tampering.
- T-MACS IS RETROFITTABLE TO EXISTING REFRIGERATION SYSTEMS — Your trailer/container's usefulness can be enhanced.
- OPERATE FOR 8 HOURS OR MORE WITHOUT EXTERNAL POWER — Data can be gathered for at least 8 hours in its standard configuration or longer without external battery assistance.
- ACCURACY OF +/- 0.5° F — Exacting temperature tolerances can be maintained.
- RESOLUTION OF +/- 0.1° F — Track minute changes in temperature.
- CELSIUS OPERATION AVAILABLE AT THE FLIP OF A SWITCH — Comply with appropriate temperature standards.
- RECORD AT INTERVALS OF FROM ONE MINUTE TO ONE HOUR — At pre-trip set up and inspection, pre select how you want to record during the trip.
- ACCUMULATE DATA FOR 2,000 HOURS OR LONGER — Depending on the output data required, a trip of 80 days or longer can be recorded.
- MULTI PROBE ADVANTAGE — Use up to three probes per single or compartmentalized trailer/containers. Monitor doubles or several adjacent containers. Probe locations and identification is part of stored record.
- MONITOR/RECORD VITAL INFORMATION — Temperature, humidity, unit status, door openings, and thermostat settings can all be recorded. In addition monitor defrost cycles, compressor run time to assist in preventative maintenance by anticipating component failure.
- USDA COLD TREATMENT PROGRAM — CargoCare generates a USDA cold treatment report.
- RUGGEDIZED CONSTRUCTION — Weatherproof, vibration proof, non-corrosive, condensation free construction mean dependable and reliable performance.
- CARGOCARE IS IBM PC COMPATIBLE — Easy to use with any IBM compatible PC.
- 2 YEAR WARRANTY — Fully backed by factory.

BRANDSTEDT CONTROLS CORPORATION IS THE INNOVATIVE LEADER

We have been providing innovative solutions to tough transport refrigeration problems for over 10 years. The T-MACS system is another example of Brandstedt's commitment to the design and manufacture of functionally useful temperature monitoring/recording devices. They will help deliver your product without costly waste, spoilage and damage.

Our technology has given innovative solutions to such diverse applications as yacht racing instrumentation with a customer list that includes the Stars and Stripes, winner of the 1987 America's Cup competition.

APPENDIX B. Text Communication Systems; Selected Literature

MDI 7031 Taxi Dispatch (262).....B-1

MDI 9031 Mobile Data Terminal (263).....B-2

"Mobile Data International's Computerized Taxi Dispatch system can increase productivity, help provide better service to your customers, improve working conditions for your drivers and, most importantly...

give you a significant advantage

Al Chesler, Vice-President, Vital Two Way Radio Taxi Inc., New York, New York.

Across North America, forward-thinking taxi companies are changing the way they dispatch cabs to customers.

They're switching from voice radio systems to the MDI Computerized Taxi Dispatch system.

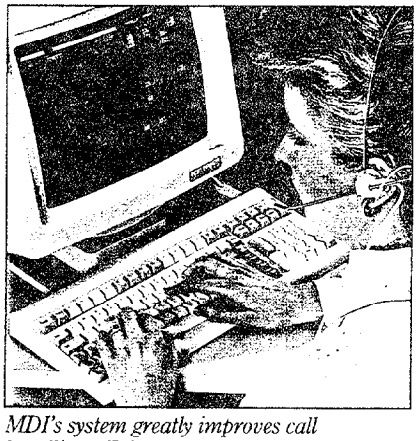
And they're reaping the benefits. One recent purchaser of MDI's system is now able to handle 40% more calls.

MDI CAN PUT THE SPEED AND EFFICIENCY OF COMPUTER TECHNOLOGY TO WORK FOR YOU.

"The computerized taxi dispatch system doesn't hold dispatches, it sends them immediately...24 hours a day. It's improved our service to customers so much that we have to expand the fleet to keep up with the volume." *Gordon MacLean, General Manager, Royal City Taxi Ltd., New Westminister, B.C. Canada.*

In the MDI system, the dispatcher is a computer.

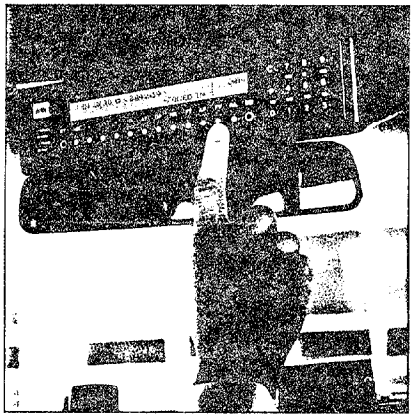
It communicates with the drivers via a compact terminal mounted in the cab. The terminal has a screen that can display two lines of text or scroll for longer messages. The data is sent over a radio channel and voice can be used as a backup system in special situations. You can get far more data system users than voice users on a radio system.



MDI's system greatly improves call handling efficiency because the dispatcher is a computer.

When a customer calls the cab company, an operator enters the address directly into the computer. The computer determines the zone of the address and validates it. The computer then advises the taxi that's next in line for a passenger in that zone and displays the address on the terminal in that taxi. And *only* that taxi. In *seconds.*

If for some reason the driver does not respond, the computer transmits the message to the next taxi in line for a passenger in that zone. If there are no taxis in the zone the computer will call one in from the nearest available zone.



The computer automatically offers the trip to the first car in the nearest zone.

BETTER CUSTOMER SERVICE MEANS MORE CUSTOMERS.

"The only thing we have to sell to customers is service. What the MDI system offers us is the improvement of service to our clients." *Allan Enders, President, Checker Cabs Ltd., Calgary, Alberta, Canada.*

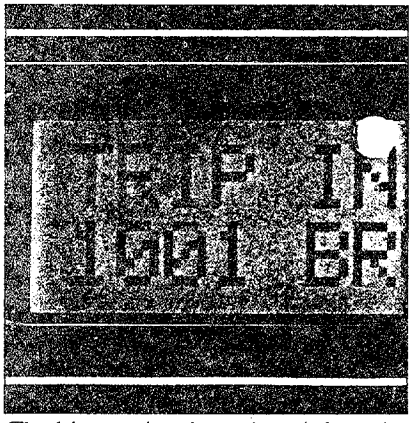
Satisfied customers become repeat customers. And that adds up to more revenue.

You can be certain that a customer is going to get a cab within a specified time because the computer doesn't forget trips, or throw away ones it doesn't like.

You'll be able to predict more accurately taxi arrival times.

A FAVORITE WITH DRIVERS BECAUSE IT DOESN'T PLAY FAVORITES.

"I love it. I don't go home with a headache every night. My cab is nice and quiet – I get more fares and make more money." *Barry Epps, Driver, Checker Cabs Ltd., Calgary, Alberta, Canada.*



The driver receives the pertinent information on a Mobile Data Terminal in his cab. Because only one cab gets the message, trip stealing is eliminated.

The computer is totally impartial. It can't be accused of giving the choice trips to poker buddies.

The computer offers the trip to the first car in line in the appropriate zone.

Drivers love the MDI syster because it's easy to learn and it's so efficient. They can book more fares per shift which means they take home more money.

ɔ over the competition."

ɹrip stealing is eliminated because the address is not broadcast to the entire fleet.

Drivers aren't distracted by constant radio chatter. And neither are their customers.

Drivers also don't have to worry about scribbling an address on a

With the MDI system voice transmission is only used for special situations. Passengers and drivers appreciate the quiet ride.

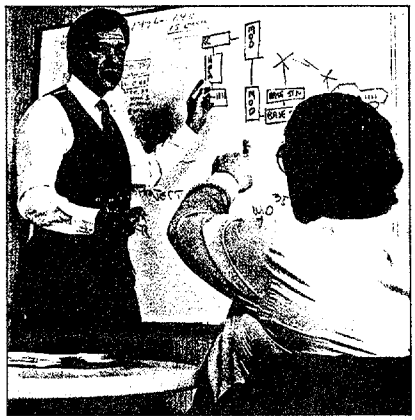
pad in the middle of a left turn. The chances of a driver misunderstanding an address are greatly reduced because he can call the digital read-out up on his screen whenever he wants.

With the MDI system, drivers have the freedom to check out the situation in other zones and, with a few quick keystrokes, re-book into a busier zone. They can leave the cab for short periods without losing their position in the line.

A SUPERIOR SYSTEM FOR SUPERVISORS.

"It's great – at high peak periods the system gets the calls out as quickly as the calls come in." *Ricky K ins, Vice-President and General Manager, American Cab Company, Austin, Texas.*

MDI automatic computer dispatching improves working



MDI people work hard to maintain our reputation as supplier of the world's best computerized dispatching and mobile data terminal systems.

conditions in the dispatch center too.

It greatly increases call handling efficiency. A constantly updated record will tell you how many cars are available in each zone and the activity in each zone. As a driver is nearing the end of one trip, he can automatically book into his destination zone. Supervisors not only know where the cabs *are,* they know where they are *going to be.*

The system accurately tracks callbacks, no-trips, response time and pre-booked calls.

For a look at the big picture, you can call up an extensive series of reports detailing everything from fleet loading at different times to the number of credit trips per vehicle.

A SYSTEM YOU CAN DEPEND ON FROM A COMPANY YOU CAN DEPEND ON.

"I trust MDI. They have a proven track record and have proven to me they know what they're doing." *Joseph Chernow, President, Greater Austin Transportation Company, Austin, Texas.*

MDI has installed tough reliable hardware and fast, effective communication systems for major organizations in the United States, Canada, Europe, the Far East, and Australia. Our very satisfied customers range from the New York City Police Department to Federal Express Corporation. And taxi companies from New York to Vancouver.

Refined through extensive research, the MDI Computerized Taxi Dispatch system is specifically designed for the needs of taxi companies.

MDI people work with you side by side to ensure your system is up and running smoothly and quickly to your total satisfaction.

NINE REASONS TO RIDE WITH MDI

1. Call-taker productivity is increased, and the customer gets better service.
2. Drivers like the system because trips are dispatched fairly and privately and the digital system ensures accuracy.
3. Everybody benefits from the system's flexibility. Drivers can choose zones where they're most likely to book a trip, calls are assigned more quickly, customers get their taxi faster.
4. The system has some particularly valuable features, including terminals with adjustable viewing angles, as well as a hidden emergency switch and voice capability for special circumstances.
5. Supervisors get instant fleet information, so they can solve problems more quickly.
6. Concise and detailed management reports tell you, among other things, which zones and times are busiest, how long customers are waiting for a cab, when no-trips are occuring and which drivers have callbacks.
7. The system is easy to learn and use.
8. Your whole organization runs more effectively and smoothly with the MDI system.
9. All of the above adds up to a *very* significant advantage over the competition.

MOBILE DATA INTERNATIONAL

9031 *And Introducing The 8100 Series Mobile Radio*

Proven Around The World

MDI Mobile Data International Inc. is the industry leader in mobile data solutions. And we're providing data communications for business on the move.

We're proud to present a performance duo that can dramatically improve your business communications.

The fifth generation of our Model 9031 mobile data terminal enables you to maintain constant, real time, two-way communication with your people on the move.

The 8100 series is a two-way FM mobile radio that is specifically designed for use with MDI mobile data terminals.

The Benefits

With the model 9031 vehicle mounted terminal you can maintain constant, real time, two-way contact with your people on the move. The 9031 gives your people pre-approved access to data bases in real time, putting the information directly in the hands of the people who need it – when they need it.

The 9031's messaging capability allows your people to communicate directly with one another so they can operate as a team.

The results are: more efficient communication, increased productivity, improved customer service, and most important, bottom line profitability.

MOBILE DATA INTERNATIONAL

We Are The Experts...

The Facts
Ergonomically designed, the 9031 is the most compact MDT on the market.

The amber CRT, proven best for visibility in all lighting conditions, displays up to 10 message lines by 32 characters on its 5-inch screen. The durable alphanumeric typewriter style keyboard allows for easy touch typing and is liquid repellent sealed to protect from contaminants.

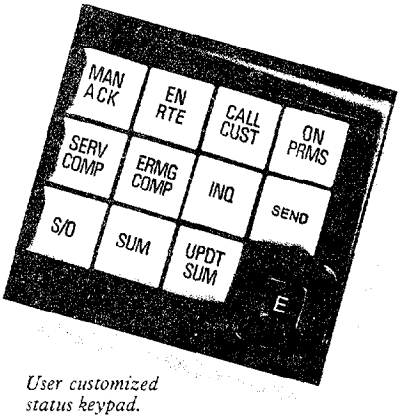
A new built-in power supply provides the terminal with solid protection during vehicle start-up power fluctuations. An entire printed circuit board has been reduced to a single microchip for increased reliability and ease of repair.

The 8100 radio is built specially to integrate with the 9031. It is only 1.7 inches high and a breeze to install. It offers two optional power levels and optional voice capability.

Designed for Flexibility
MDI designs mobile data communications systems to fit within your present network.

We use modular building block methods; our equipment packages can expand with your business when you're ready.

MDI is one hundred percent committed to mobile data communications. It is our business and our only business.
We *are* the experts.



User customized status keypad.

Specifications...

9031

Physical
Size: W10.6 x H9.9 x D7.9 inches
(W27 x H25 x D20 cm)
Weight: 7.7lbs (3.6kg)
Display: Amber 5-inch diagonal cathode ray tube (CRT).
Controls: Intensity controls for display and keyboard illumination.

Environmental
Operating Temperature:
-22F to +140F (-30C to +60C)
Storage Temperature:
-40F to + 185F (-40C to +85C)
Vibration: Meets or exceeds EIA RS 204

Functional
Message Capacity: 100 message lines of 32 characters each.
Forms Capacity: 64 lines of 32 characters for downloadable forms storage.
Status: Ten user specified single key functions.
Addressing: One individual call, one universal all call, and seven group call addresses per terminal.
System Monitoring: Continuous status on six critical system parameters displayed at bottom of screen.
Keyboard: Non-glare keys with good tactile feedback. Alphanumeric-standard typewriter layout. Liquid repellent sealing under keyboard protects from contaminants.
Character Set: 64 character ASCII plus 64 character graphics symbol subset.

Transmission
Data Rate: 4800 bits per second.
Radiated Bandwidth: Meets or exceeds EIA RS 152B and DOC RSS119 standards.
Modulation: Baseband on FM.
Undetected Errors: 1 in 10 billion characters.

Electrical
Voltage: Input voltage 10 to 18 VDC normal operation; 5.0 to 18 VDC without loss of memory.
Input Current: Less than 1.5 amp with full screen display at 13.8 VDC. Less than 0.8 amp with display blanked. Maximum current 2.5 amp over the rated voltage range.
Signal Input: Adjustable 250 mV to 2.5V peak to peak.
Signal Output: Adjustable 0V to 2.5V peak to peak.

8100

Physical
Size: W10.6 x H1.7 x D8
(W27 x H4.3 x D20.3cm)
Weight: 5.5lbs (2.5kg)

Functional
Frequency Range:
Transmit – 806.0125 to 820.9875 MHz
Receive – 851.0125 to 865.9875 MHz
Channel spacing: 25 KHz
Channel capacity: 16 frequency synthesized

Transmitter
Power output HP version: 15 to 25 watts adj.
Power output LP version: 5 watts.
Frequency stability: 2.5 ppm, -30 to +60C
Spurious and Harmonic Emissions -60 dBc
Frequency separation bandwidth: 5 MHz

Receiver
Frequency stability: 2.5 ppm -30 to +60C
Sensitivity, 12 dB SINAD: 0.35 uVolt
Adjacent channel selectivity: 70 dB
Spurious and image rejection 70 dB
Intermod rejection 65 dB
Frequency separation bandwidth: 5 MHz
Modulation acceptance bandwidth: 8 KHz

MOBILE DATA INTERNATIONAL

Data Communications For Business On The Move

Mobile Data International Inc.
11411 Number Five Road,
Richmond, B.C. Canada V7A 4Z3
Phone 604-277-1511
U.S. Toll Free 800-663-8376
FAX 604-277-2178
Telex 04-355865

APPENDIX C. Vehicle Information Systems; Selected Literature

FMSS 1330 (207 A/B).....C-1

CADEC 100,200,300 (208 A/B/C).....C-2

Fleet Data Master (209).....C-3

UNIPARS Monitoring System (213).....C-4

Silent 1000 (214).....C-5

Tripmaster (217 A/B/C).....C-6

Data Com (220).....C-7

System 7000 (222).....C-8

Driver Information System (240).....C-9

TC-1 (242).....C-10

AL 100 (264).....C-11

MILOG (266).....C-12

ARGO FMS™ 1330

THE ARGO FMS 1330 ON BOARD COMPUTER

...providing computerized cost control

and risk management

for today's more competitive

fleet environment

Increase safety • Control fuel costs •

FMS 1330

...a computerized data-gathering system to help you reduce excessive fuel, labor and operating costs.

The Argo FMS 1330 Fleet Management System is an automated diagnostic tool that starts providing data the moment a vehicle returns to your terminal.

Just pop the on-board cartridge into the reader unit, and a management-by-exception printout plays back—in plain English, and on a single page—what happened on that very run...even as the engine is still cooling.

WHAT THE SYSTEM TELLS YOU

This computer information system is the latest achievement in Argo's 60 years of fleet management system leadership. It tells you...

...who, what, when and where there's waste in fuel, driver labor and maintenance costs

...whether the speed limit was observed

...whether the engine was operating in the economy range

...whether driving and stopping times are in line with your standards

...whether there was excessive engine idling

...whether speed, rpms and engine idling are within the standards you've set for profitability.

In short, Argo's Fleet Management System helps you operate leaner and be more profitable.

Reduce maintenance • Decrease labor costs

THE ARGO FMS SPEEDS THE FLOW OF DATA FROM THE POINT OF ORIGIN TO THE POINT OF DECISION

...and facilitates a team approach to your war on waste

"SIMPLE PLUS TRIP REPORTS" INCLUDE A ONE-PAGE PRINTOUT THAT TELLS YOU EVERYTHING.

The lead document in the Argo "Simple Plus Trip Report" package is a single, letter-sized printout.

Your supervisors don't have to plough through a mountain of paper to find pertinent figures. Just insert the "still warm" cartridge into the reader unit and you get a "report card" that's simple to understand and act on.

The data—in plain English—gives you an exception report that easily translates into a positive action plan.

EXCEPTION REPORT RED FLAGS THE DRIVER WHO'S OUT OF LINE WITH YOUR PROFITABILITY STANDARDS.

Your drivers are your first line of defense against runaway costs. They're the ones who decide whether you'll save on fuel by watching their speed and rpm's, and by knocking off the excessive engine idling.

The Argo FMS helps your drivers make these positive contributions and pinpoints the potential for improvement. It also lets them know how important their contributions are to the success of your operation.

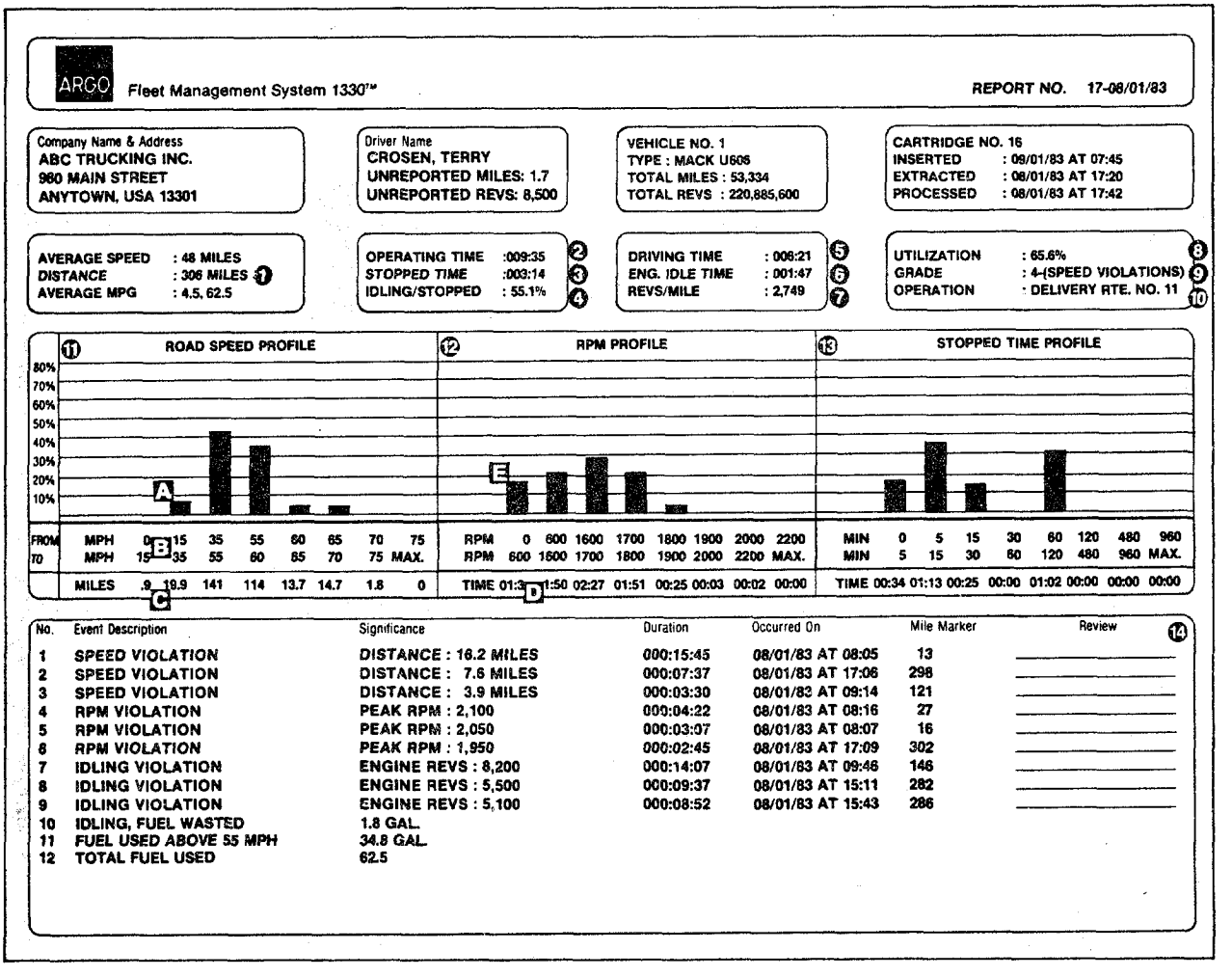
DECISION MAKERS CAN ACT FASTER TO CONTROL COSTS

Because you are dealing with "NOW" information, you can respond quickly to excessive costs. And because the Argo printout gives you the end result first, you don't need to muddle through countless intermediate steps to reach the bottom line.

3

The Argo Standard Trip Report

The Argo Standard Trip Report is the lead document in the package of "Simple Plus Trip Reports." Its special feature is the "grade"—an easy-to-use yardstick that lets you quickly judge driver performance and measure the cost of each trip.



ARGO Fleet Management System 1330™ — REPORT NO. 17-08/01/83

Company Name & Address
ABC TRUCKING INC.
960 MAIN STREET
ANYTOWN, USA 13301

Driver Name
CROSEN, TERRY
UNREPORTED MILES: 1.7
UNREPORTED REVS: 8,500

VEHICLE NO. 1
TYPE : MACK U606
TOTAL MILES : 53,334
TOTAL REVS : 220,885,600

CARTRIDGE NO. 16
INSERTED : 08/01/83 AT 07:45
EXTRACTED : 08/01/83 AT 17:20
PROCESSED : 08/01/83 AT 17:42

AVERAGE SPEED	: 48 MILES	OPERATING TIME	:009:35 (2)	DRIVING TIME	: 008:21 (5)
DISTANCE	: 306 MILES (1)	STOPPED TIME	:003:14 (3)	ENG. IDLE TIME	: 001:47 (6)
AVERAGE MPG	: 4.5, 62.5	IDLING/STOPPED	: 55.1% (4)	REVS/MILE	: 2,749 (7)

UTILIZATION	: 65.6%	(8)
GRADE	: 4-(SPEED VIOLATIONS)	(9)
OPERATION	: DELIVERY RTE. NO. 11	(10)

(11) ROAD SPEED PROFILE — 80% 70% 60% 50% 40% 30% 20% 10%

FROM									
70	MPH	0	15	35	55	60	65	70	75
	MPH	15	35	55	60	65	70	75	MAX.
	MILES	.9	19.9	141	114	13.7	14.7	1.8	0

(12) RPM PROFILE

RPM	0	600	1600	1700	1800	1900	2000	2200
RPM	600	1600	1700	1800	1900	2000	2200	MAX.
TIME	01:3	1:50	02:27	01:51	00:25	00:03	00:02	00:00

(13) STOPPED TIME PROFILE

MIN	0	5	15	30	60	120	480	960
MIN	5	15	30	60	120	480	960	MAX.
TIME	00:34	01:13	00:25	00:00	01:02	00:00	00:00	00:00

(14)

No.	Event Description	Significance	Duration	Occurred On	Mile Marker	Review
1	SPEED VIOLATION	DISTANCE : 16.2 MILES	000:15:45	08/01/83 AT 08:05	13	
2	SPEED VIOLATION	DISTANCE : 7.6 MILES	000:07:37	08/01/83 AT 17:06	298	
3	SPEED VIOLATION	DISTANCE : 3.9 MILES	000:03:30	08/01/83 AT 09:14	121	
4	RPM VIOLATION	PEAK RPM : 2,100	000:04:22	08/01/83 AT 08:16	27	
5	RPM VIOLATION	PEAK RPM : 2,050	000:03:07	08/01/83 AT 08:07	16	
6	RPM VIOLATION	PEAK RPM : 1,950	000:02:45	08/01/83 AT 17:09	302	
7	IDLING VIOLATION	ENGINE REVS : 8,200	000:14:07	08/01/83 AT 09:46	146	
8	IDLING VIOLATION	ENGINE REVS : 5,500	000:09:37	08/01/83 AT 15:11	282	
9	IDLING VIOLATION	ENGINE REVS : 5,100	000:08:52	08/01/83 AT 15:43	286	
10	IDLING, FUEL WASTED	1.8 GAL.				
11	FUEL USED ABOVE 55 MPH	34.8 GAL.				
12	TOTAL FUEL USED	62.5				

AVERAGE SPEED	: 48 MILES
DISTANCE	: 306 MILES
AVERAGE MPG	: 4.5, 62.5

1

DISTANCE. Total miles tells you whether your driver took the scheduled route or his own "scenic" route.

OPERATING TIME	:009:35
STOPPED TIME	:003:14
IDLING/STOPPED	: 55.1%

2

OPERATING TIME is the total time the cartridge was inserted in the monitor.

OPERATING TIME	:009:35
STOPPED TIME	:003:14
IDLING/STOPPED	: 55.1%

3

STOPPED TIME shows when a driver is off the road.

OPERATING TIME	:009:35
STOPPED TIME	:003:14
IDLING/STOPPED	: 55.1%

4

IDLE/STOPPED TIME. This important ratio pinpoints the percentage of time that your vehicle was idling and your fuel was wasted while the vehicle was stopped.

DRIVING TIME : 006:21
ENG. IDLE TIME : 001:47
REVS/MILE : 2,749

5

DRIVING TIME shows when a driver is working.

DRIVING TIME : 006:21
ENG. IDLE TIME : 001:47
REVS/MILE : 2,749

6

ENGINE IDLING TIME. A single-figure indicator that alerts you to fuel waste.

DRIVING TIME : 006:21
ENG. IDLE TIME : 001:47
REVS/MILE : 2,749

7

REVS/MILE. Shows you how many engine revolutions it took to go one mile—helps to show up those drivers that make the engine work harder for each mile they drive.

UTILIZATION : 65.6%
GRADE : 4-(SPEED VIOLATIONS)
OPERATION : DELIVERY RTE. NO. 11

8

UTILIZATION. This ratio of driving time to total operating time is a bottom-line indicator of vehicle productivity. This single figure can tell whether the run could have been performed more efficiently.

DRIVER PERFORMANCE MONITOR

UTILIZATION : 65.6%
GRADE : 4-(SPEED VIOLATIONS)
OPERATION : DELIVERY RTE. NO. 11

9

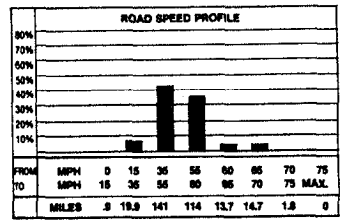
GRADE. The Standard Trip Report provides this single-figure summary of a driver's performance for a particular period. The grade is based on your own parameters. These could include your company's speed limit...amout of engine idling time...operating in the economy range...driving and stopped time...type of trip (over-the-road, P&D, or other tasks.)

The grade is a cumulative average of all factors. A lower-than-average grade is your early warning. It pinpoints precisely where you should take corrective action to block runaway costs. (In this particular case the driver received a low grade of 4, largely because of excessive speeding. The minus sign indicates his performance was below the fleet average).

UTILIZATION : 65.6%
GRADE : 4-(SPEED VIOLATIONS)
OPERATION : DELIVERY RTE. NO. 11

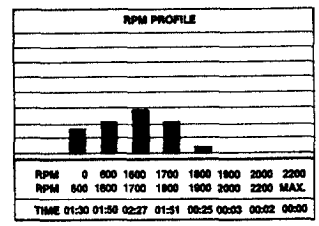
10

OPERATION. Shows type of run—over-the-road, P&D or other assignment, and is part of the base information for each driver's grade.



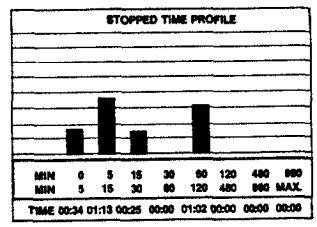
11

ROAD SPEED PROFILE gives you a picture of a driver's speed during a particular trip. The bar for each speed range indicates the percentage of total mileage (A) a driver was in a particular range (B), and the miles driven in each range (C), which easily lets you pinpoint time spent driving above the speed limit.



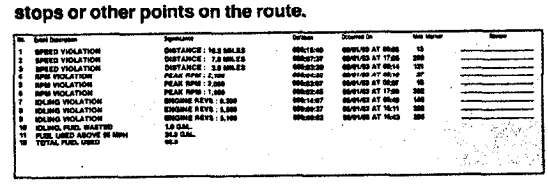
12

ENGINE SPEED PROFILE provides a pictograph of driving or not driving in the economy range, and excessive idling. Shows the amount of time a driver was in each range (D)...and also the percentage of total time in each range (E).



13

STOPPED TIME PROFILE shows you at a glance how long your driver stopped within the pre-set time ranges. Lets you know whether the majority were short stops for traffic lights or traffic delays, or whether there were long stopped periods and delays at loading docks, truck stops or other points on the route.



14

VIOLATION SPOTLIGHT. If a driver has failed to meet standards, then the longest violations will be automatically printed as explicit single-event recordings. Speed violations, for example, show the number of miles and minutes and seconds that the violation lasted, and at which mile marker it happened. RPM violations show RPM peaks reached and date and time they occured and at which mile marker.

You can choose to record other events such as low engine oil pressure or high water temperature, exhaust gas temperature or number of brake applications or other special events. The appropriate sensor must then be installed and the information will be recorded in the event section of your report.

Up to 15 recordings fit into that report area, and you can choose and print out those you want on a priority basis.

HOW TO USE THIS PRINTOUT AS A MANAGEMENT-BY-EXCEPTION REPORT

The report alerts you to the exceptions from norms for important factors in your operation—speeding, operating out of the economy range, engine idling time and vehicle utilization.

The report pinpoints sub-standard driver or vehicle performance...so you can concern yourself with correcting just these exceptions instead of digging through a mountain of figures for key fleet performance indicators.

The printout becomes your decision-making tool to correct negative operating factors faster.

ADDITIONAL "SIMPLE PLUS TRIP REPORTS"

BASIC TRIP REPORT

Fleet Management System 1330™

YOUR COMPANY

DRIVER'S NAME

DEPARTED	MILES	MPH	ARRIVED	ST. HRS.	LOC.
07:30, 02/12	45	32	08:54	000:40	45
09:36	12	23	10:43	000:25	57
11:51	8	45	12:08	001:10	65
13:18	84	52	14:54	000:16	149
15:10	29	35	15:59	000:28	178
16:27	16	30	17.20	000:00	194
02/12 ===>	194 miles				

Each trip is broken down into individual trip legs, indicating miles driven, average speed, time of arrival and duration of stop.

DRIVER INPUT REPORT

DEPARTED	MILES	MPH	ARRIVED	ST. HRS.	LOC.
07:30, 02/12	45	32	08:54	000:40	45
--> LOCATION: HENSON'S MKT., HH:MM					
--> CASES UNLOADED: 150 AT 09:05					
09:36	12	23	10:43	000:25	57
--> LOCATION: JOHNSONS, HH:MM					
--> CASES UNLOADED: 325 AT 10:48					
11:51	8	45	12:08	001:10	65
IDLING: TRIP SEGMENT TOTAL 000:12:14, # of Times: 2					
--> LOCATION: LUNCH, HH:MM					
13:18	84	52	14:54	000:16	149
SPEEDING: TRIP SEGMENT TOTAL: 000:13:28, # of Times: 1					
--> LOCATION: KIM'S MARKET, HH:MM					
--> CASES UNLOADED: 45 AT 15:01					
--> STATE: PENNSYLVANIA 14:12 AT MILE 130					
15:10	29	35	15:59	000:28	178
--> LOCATION: SUPERVALUE, HH:MM					
--> CASES LOADED: 420					
--> CASES UNLOADED: 50					
16:27	16	30	17:20	000:00	194
--> LOCATION: YARD, HH:MM					
--> FUEL: 200 GAL., 17:35 AT MILE 194					
02/12 ===>	194 Miles				

TRIP SUMMARY:

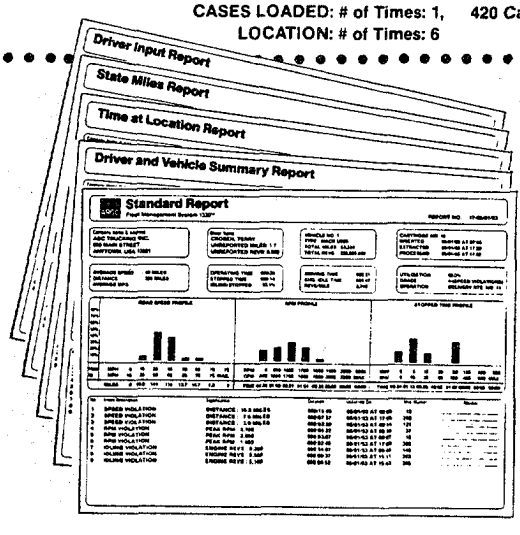
FUEL: # of Times: 1,	200 GAL.	STATE: MILES
CASES LOADED: # of Times: 4,	570 Cases	MARYLAND: 130
CASES LOADED: # of Times: 1,	420 Cases	PENNSYLVANIA: 64
LOCATION: # of Times: 6		

When the Driver Input Device is used the Driver Input Report shows all of the information on the Basic Trip Report plus additional entries made by the driver.

Every driver entry appears individually with the time each entry was made and, when applicable, with a mile marker.

Driver input information covers a broad range of data: time spent at individual locations, state line crossings, cargo picked up or delivered, fuel purchased, toll road useage, etc. It lists the details management needs to be fully informed.

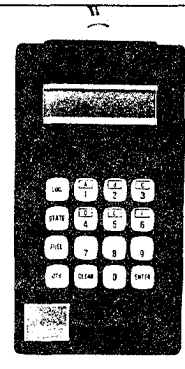
A trip summary given at the end of the report provides management with a total overview. This summary report can be used for fuel tax reporting or general management information. Each line can be either a trip leg, driver entry or summary information.



New "Simple Plus Trip Reports" expand the range of information available from the Argo on board computer. The following are some of the reports offered:

1) State Miles Report
2) Time at Location Report
3) Driver and Vehicle Summary Report
4) Various Management Reports

The Argo system can also produce custom reports tailored to your needs.



DRIVER INPUT MODULE

Involves driver in the reporting process. The driver can enter such data as

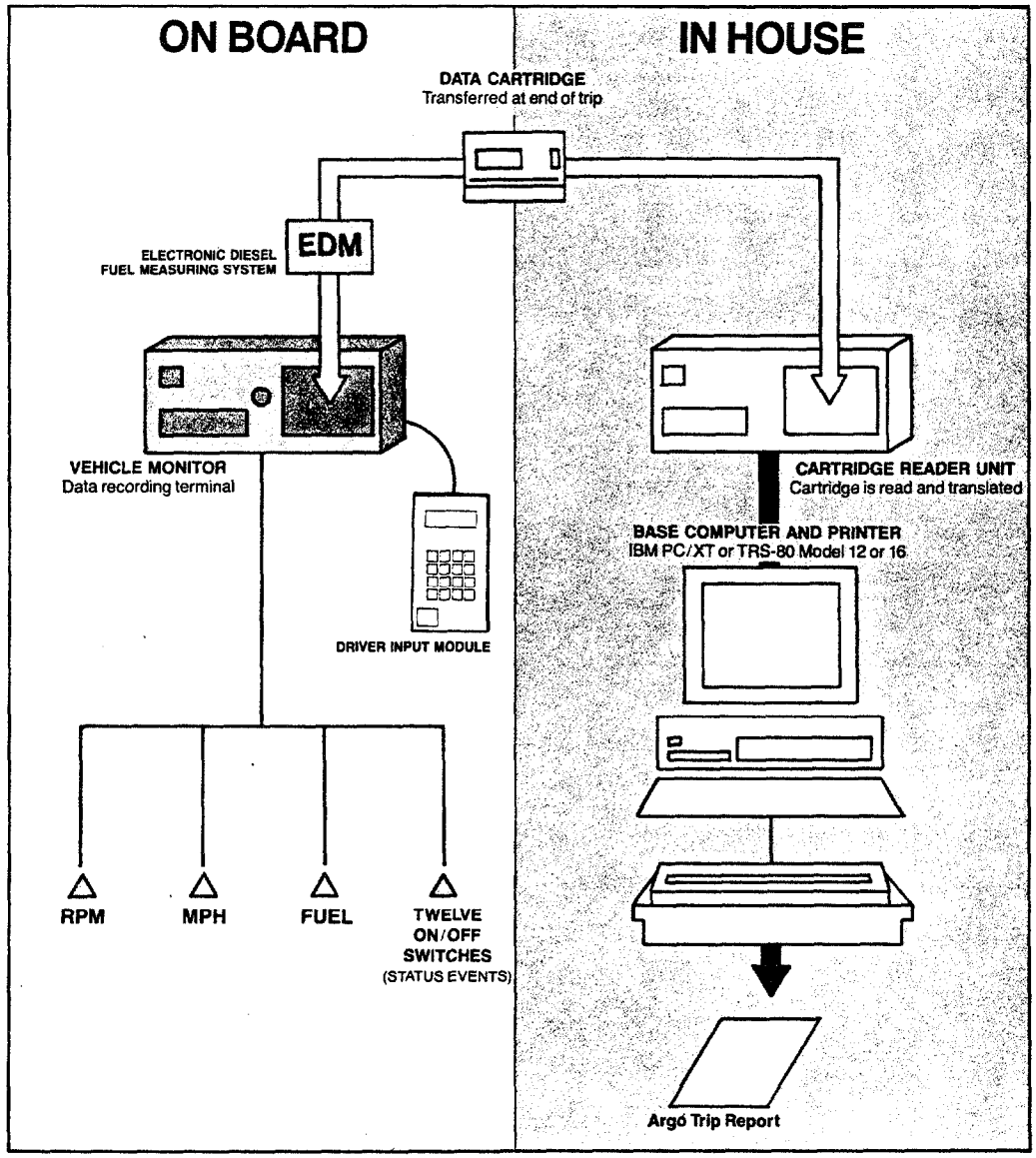
1) location
2) state
3) fuel
4) type of job
5) quantity (crates, boxes, gallons) or any other entry defined by management.

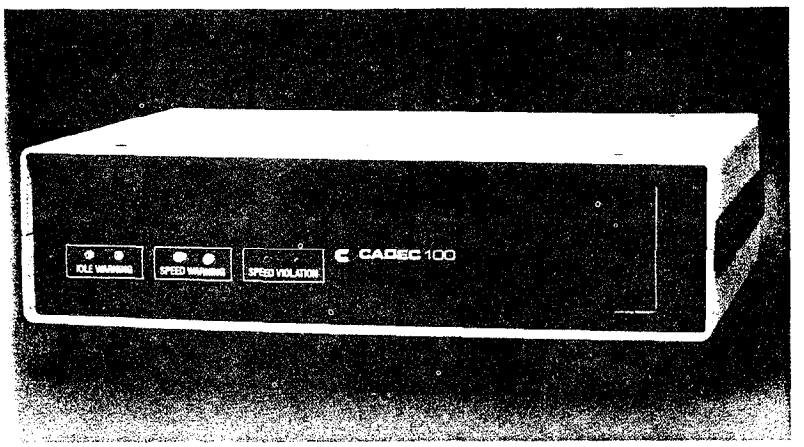
Not just a data-gathering system...but a solution system

The Argo FMS 1330 consists of an on-board monitor into which the driver inserts his cartridge. The vehicle is equipped with MPH, RPM and Status Event sending units as selected by you. These units will input the data into the monitor.

At the end of each run the driver brings his cartridge to the office where the trip data is extracted and the cartridge is prepared for the next trip. FMS software and hardware transform the cartridge contents into an easy-to-use exception report.

Argo FMS 1330: how the pieces fit together and work together

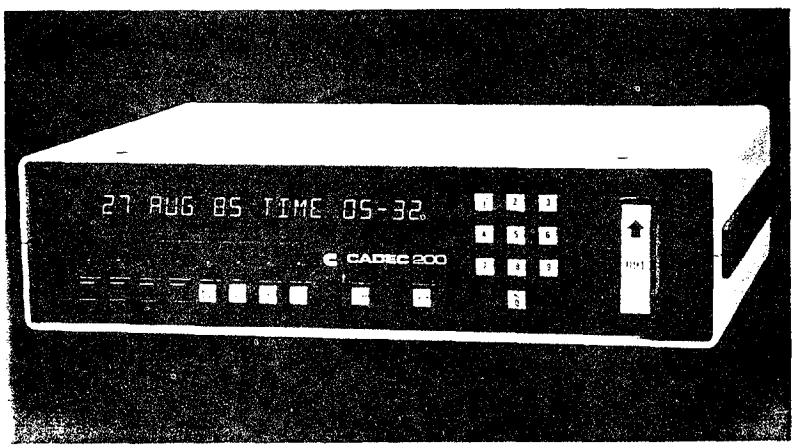




Cummins CADEC 100 is a basic trip recorder with tachometer, odometer and ignition sensor input. It coaches the driver to operate the vehicle according to corporate guidelines.

Primary Benefits:

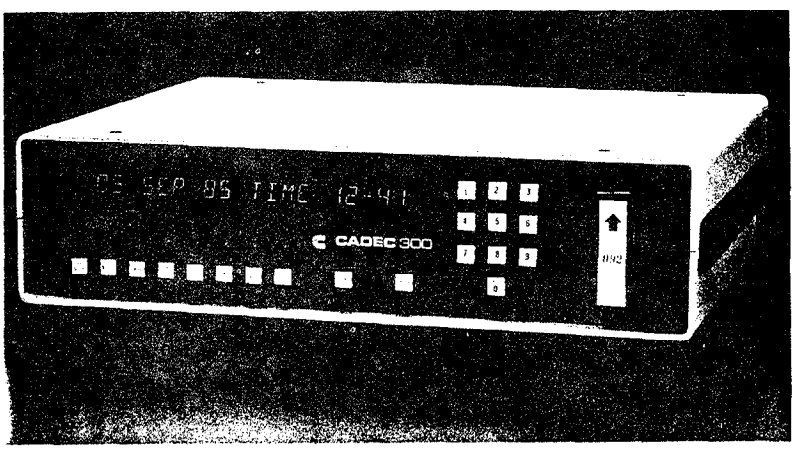
Fuel savings, improved driver performance and maintenance efficiencies.



This unit is an advanced Vehicle Information System which combines automatic sensor data with input from the driver to monitor trip activity and costs, reduce driver and clerical paperwork and improve overall fleet management information.

Primary Benefits:

Fuel savings, maintenance efficiencies, fleet productivity and operating efficiencies along with automated fuel tax reporting and reduced clerical paperwork.



The Cummins CADEC 300 is the most advanced Vehicle Information System. It provides sensor input from the tachometer, odometer and ignition, monitors fleet operations, identifies trip costs, reduces driver and clerical paperwork, plus it automatically manages the driver's DOT log.

Primary Benefits:

Fuel savings, maintenance efficiencies, fleet productivity and operating efficiencies, automated fuel tax reporting, reduced clerical paperwork and improved safety through the on-board recording of hours of service with computer-generated driver logs.

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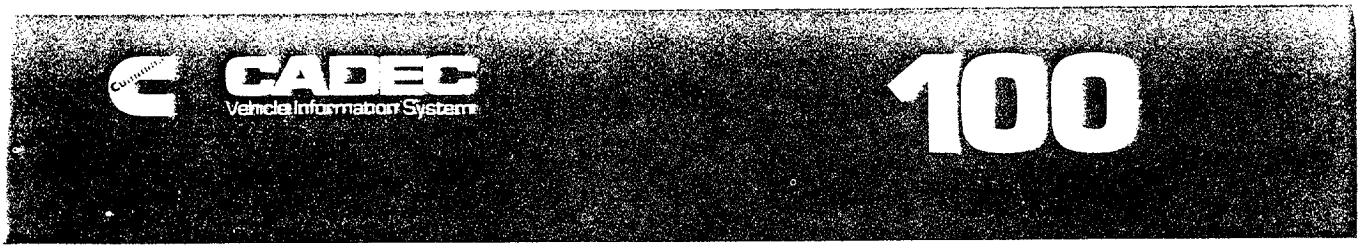


Cummins CADEC 100 is a basic trip recorder with tachometer, odometer and ignition sensor input. It coaches the driver to operate the vehicle according to corporate guidelines.

Primary Benefits:

Fuel savings, improved driver performance and maintenance efficiencies.

Standard Reports
Software for the Cummins CADEC 100 generates these reports:
- Trip Report
- Driver Performance
- Vehicle Maintenance Scheduling
- Miles Per Gallon Performance

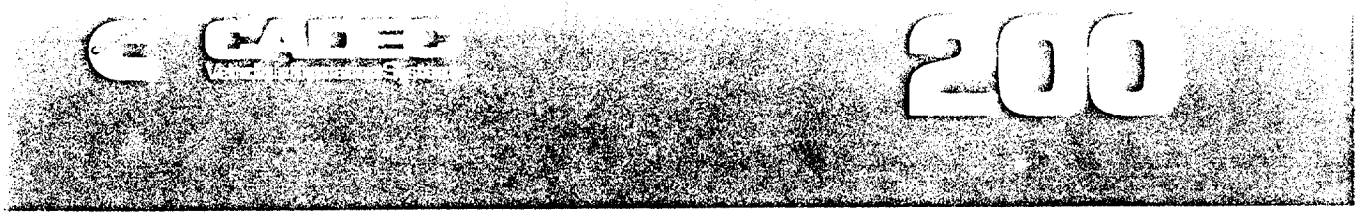
General CADEC Information

Hardware

On-Board Computer
- The Cummins CADEC 100 has three sets of indicator lights which are activated when idle conditions or speeding conditions exist.
- The system contains a date and time clock, plus a rechargeable battery backup capability, which will retain information [in memory] for more than 30 days.
- The Cummins CADEC 100 uses a Motorola 6800 processor and has 22K of memory.
- The system provides three serial ports used for sensor connection... ignition, odometer, tachometer.
- The system is designed to operate in temperatures ranging from -40°F to +185°F.

Data Cartridge
This portable cartridge contains solid-state CMOS memory along with 90-day battery backup and date and time clock. The cartridge is available in 8K or optional 16K of memory.

Events recorded by the Cummins CADEC on-board computer are stored in the data cartridge until transferred to an IBM PC-AT via the Cummins CADEC Data Link.



This unit is an advanced Vehicle Information System which combines automatic sensor data with input from the driver to monitor trip activity and costs, reduce driver and clerical paperwork and improve overall fleet management information.

Primary Benefits:

Fuel savings, maintenance efficiencies, fleet productivity and operating efficiencies along with automated fuel tax reporting and reduced clerical paperwork.

Driver Input Functions
Trip Activities - CADEC allows the driver to enter his complete daily activities. He can enter all necessary details of his pickups, deliveries, expenses, fuel purchases and delays.

State/Toll - As a driver crosses state lines, he can indicate the state and whether or not he is on a toll road. The miles for each state are then automatically computed for tax purposes.

Expenses - The driver can enter type of expense and amount as he incurs them along his route.

All of the information collected is formatted and stored in the data cartridge. Additionally, the driver entry software program has been designed to facilitate individual fleet information needs.

Standard Reports
Software for the Cummins CADEC 200 generates these reports:
- Trip Report
- Driver Performance
- Vehicle Maintenance Scheduling
- Miles Per Gallon Performance
- Driver's Expense Report
- Over, Short & Damaged Materials
- State Fuel Tax Report

Optional Reports
These reports provide summaries of the Standard Reports for customer defined time periods. These programs are modular and may be purchased separately for the Cummins CADEC 200 unit.
- Account Delay Detail Report
- Account Delay Summary Report
- Driver Productivity Report
- Empty Mile Ratio Report

General
CADEC
Information

Hardware

On-Board Computer

- The Cummins CADEC 200 system has four function buttons, a 10-digit numeric keypad, and a 20-character digital display.
- There are two additional function buttons for clearing or entering information, giving the operator an opportunity to "erase" any incorrect entries.
- The system contains a date and time clock, plus a rechargeable battery backup capability, which will retain information (in memory) for more than 30 days.
- The processor is a Motorola 6800 and the system has 22K memory.
- The system provides three serial ports used for sensor connection. Sensors currently available are ignition, odometer and tachometer.
- The system is designed to operate in temperatures ranging from -40°F to +185°F.

Data Cartridge

This portable cartridge contains solid-state CMOS memory along with 90-day battery backup and date and time clock. The cartridge is available in 8K or optional 16K of memory.

Events recorded by the Cummins CADEC on-board computer are stored in the data cartridge until transferred to an IBM PC-AT via the CADEC Data Link.

Data Link

The Data Link retrieves information upon operator command from the data cartridge and outputs it in RS232-C, Serial asynchronous, ASCII (TTY compatible) format to the IBM PC-AT.

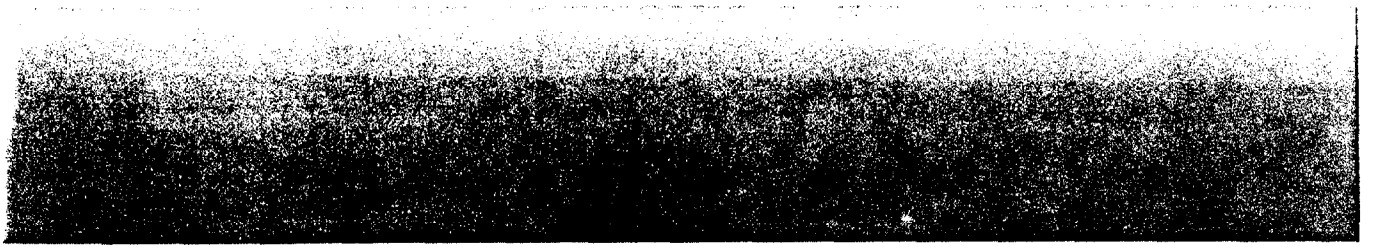
Additionally, when data has been successfully transferred, the Data Link (under operator command) initializes the data cartridge and sets the date and time clock.

The Data Link has six function buttons, CLEAR and ENTER keys, a 10-digit numeric keypad, and a 20-character digital display.

The processor in the Data Link is a Motorola 6800 and the system has 22K of memory. There is one serial port to facilitate connection to the IBM PC-AT.

Input power is through a 12-volt converter, which is an integral part of the power cord supplied with the unit.

The unit plugs into any standard 110 A.C. power outlet.



Software

All software is granted to the user on a license basis only for use on one computer.

The standard software configuration operates on an IBM PC-AT computer. [Please refer to Cummins CADEC System configuration guidelines for further information.]

System Manager

This software includes the following programs:

- Data Link Interface
- File Manager
- Dispatch Program
- Edit Program
- Utility Systems Configuration Program
- Vehicle Calibration Program

Data Conversion Program

This program will convert the Cummins CADEC data base to an ASCII file. This capability will enable the data to be further analyzed using popular spread sheet programs or user application programs.

On-Board Computer Software

The Cummins CADEC on-board computers have standard operating programs called "firmware." They reside in PROM [Programmable Read Only Memory] in each respective unit and permit user-friendly interaction between the driver and the Cummins CADEC 200 unit.

Documentation

Driver's Guide

One Driver's Guide is provided with each CADEC on-board computer. It describes for the driver the procedures for operating the Cummins CADEC 200 and includes a convenient section for your fleet's own codes.

Dispatcher's Guide

The Dispatcher's Guide is provided with each Data Link. It describes for the dispatcher the procedures for operating the CADEC 200 Data Link and software.

CADEC Vehicle Information System

C200R/C300R

C200 REMOTE

The CADEC C200R is an advanced Vehicle Information System which combines automatic sensor data from the tachometer, odometer and ignition with input from the driver to monitor trip activities, trip costs, reduce paperwork and improve overall fleet management information.

C300 REMOTE

The CADEC C300R is the most advanced in the line of CADEC Vehicle Information Systems. It provides sensor input from the tachometer, odometer and ignition, monitors fleet operations, identifies trip costs, reduces driver and clerical paperwork, and electronically produces the driver's DOT log and maintains available hours by driver.

Primary Benefits

The CADEC C200R offers the option of using a smaller, more versatile remote mount display while still improving the fuel savings, operating and maintenance costs and fleet productivity as with the standard CADEC C200. In addition, automated fuel tax reporting and reduced clerical paperwork are available with both the CADEC C200 and C200R.

The CADEC C300R not only offers you all of the benefits of the C200R, but it also features improved safety through the on-board recording of hours of service with computer generated driver DOT logs. The CADEC C300R is also a remote display unit whose mounting options are varied because of its compact size.

Product Overview

The CADEC C200R and C300R Vehicle Information Systems monitor performance and provide data entry capabilities for the trucking industry to aid in meeting many of today's needs in fleet management. The remote CADEC units have a modular concept that allows the display and the data entry functions of the on-board computer to be performed via a remote interface. The units' compact size provides infinite mounting possibilities within today's smaller cabs. The C200R and C300R, as well as our other systems, use state-of-the-art data acquisition processing, storage and communications techniques. For further information on the CADEC 200 and 300 systems, see additional product information included in this folder.

Dimensions:

Height	3"
Width	12½"
Depth	4"

Height	3"
Width	12½"
Depth	4"

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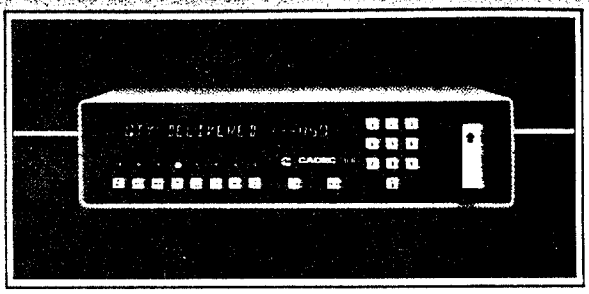


During recent years, fleet managers have been besieged by escalating costs and increased paperwork. The most disconcerting of these costs are for fuel, recordkeeping and driver wages.

Vehicle monitoring devices and on-board computers are designed to help Fleet Management control these high cost areas, reduce paperwork and provide timely management information. However, many questions still exist regarding on-board computers. This booklet is written in a simple question and answer format to help give you a better understanding of on-board computers and the Cummins CADEC Vehicle Information System.

THE HISTORY OF VEHICLE ON-BOARD COMPUTERS

The evolution started some thirty years ago. One of the very first vehicle monitoring devices was a tachograph. The tachograph specifically monitored speed and rpm. It had its limitations in that it was difficult to read and the tachograph itself was very susceptible to tampering.

In the 1970's a new type of device came to the market. Called a Vehicle Management System or Trip Recorder, it monitors speed, rpm, and also has limited driver-input capability. The Trip Recorder continues to address engine performance but does little to address driver productivity issues. It is little more than a computerization of the tachograph.

The new generation of on-board computers is here—the Vehicle Information System—designed for the 1980's, 1990's and beyond.

SYSTEMS IN GENERAL

Q *What kinds of systems are available to help me manage and evaluate my fleet's performance and profitability?*

A There are three types of fleet data acquisition systems. Each has unique capabilities:

- The Engine Monitoring System (Tachograph)
- The Vehicle Management System (Trip Recorder)
- The Vehicle Information System (VIS)

Q *How are they different?*

A Each system represents a different generation of technology:

1950-1960s	*TACHOGRAPH* The Tachograph was simple motion detection equipment, making it possible to acquire limited vehicle and trip data.
1970s	*TRIP RECORDER* The Trip Recorder is a computerized tachograph for the acquisition and processing of basic vehicle and trip data.
1980s and beyond	*VEHICLE INFORMATION SYSTEM* Vehicle Information Systems are superior hardware/software products designed to acquire, process, store and communicate a broad range of vehicle driver trip data.

Q *Tachographs are still used by some fleets—don't they provide adequate information?*

A Not really. Tachographs can only identify periods of motion and non-motion by recording speed and engine rpm.

Q *But isn't that enough information to manage fleet fuel consumption?*

A Not totally. Tachograph results can be misinterpreted. For example, a driver may be maintaining 55 mph but doing so in ninth rather than tenth gear. This is not easily detected by the tachograph. In addition, a tachograph can't provide the information required to control or improve labor productivity. At best, speed and rpm can be monitored for eventual comparison to company standards.

Q *What about the second generation—the Vehicle Management System, or Trip Recorder. Is that another name for an on-board computer?*

A Yes, but a Trip Recorder is more accurately described as an on-board "computerized tachograph." This high-tech version of the tachograph can measure and record a vehicle's road speed, rpm, fuel usage, maintenance information, idle time and stop duration time. Drivers, however, feel they are being constantly monitored and that the company assumes they are doing something wrong.

Q *How is Trip Recorder data used?*

A The information collected by a Trip Recorder is input to a local computer for processing. A number of reports can then be produced to indicate a driver's compliance or non-compliance to company policy (e.g., whether the engine was operated in the economy range; if driving and stopping times were adhered to; if speed, rpm and idling were within a set criteria, etc.).

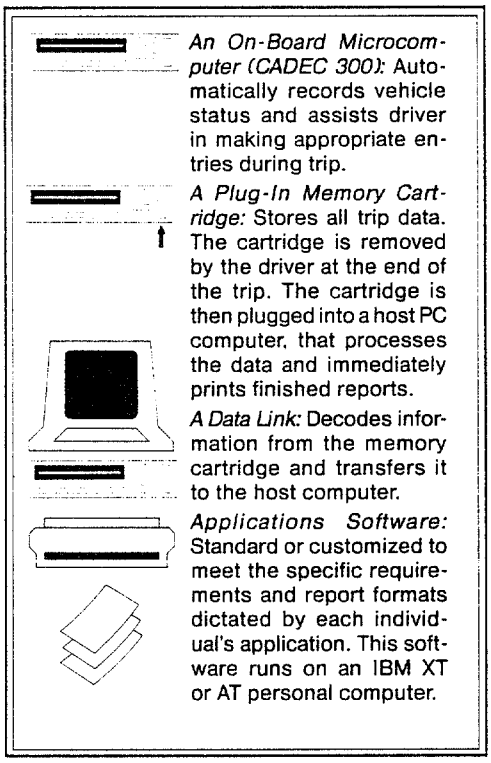
Q *Are operational savings possible with an on-board Trip Recorder?*

A Most carriers who install Trip Recorder devices achieve savings from reduced fuel consumption.

A No. Although the standard fleet reports cover most fleet information requirements, customized software can produce reports in virtually any desired format, including your existing format.

Q *How many components are actually involved in a Cummins CADEC VIS?*

A In addition to your computer and printer, four basic components make up the Cummins CADEC VIS:

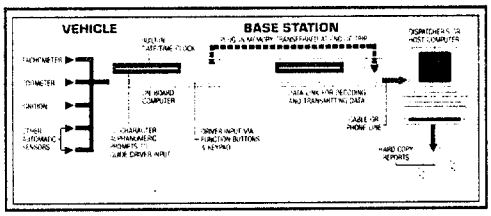


An On-Board Microcomputer (CADEC 300): Automatically records vehicle status and assists driver in making appropriate entries during trip.

A Plug-In Memory Cartridge: Stores all trip data. The cartridge is removed by the driver at the end of the trip. The cartridge is then plugged into a host PC computer, that processes the data and immediately prints finished reports.

A Data Link: Decodes information from the memory cartridge and transfers it to the host computer.

Applications Software: Standard or customized to meet the specific requirements and report formats dictated by each individual's application. This software runs on an IBM XT or AT personal computer.



Q *What additional information does the Cummins CADEC 300 VIS on-board computer provide compared to a Trip Recorder?*

A Virtually unlimited employee input! Data is entered by the driver with a simple series of key strokes. This data can be supplementary information regarding such things as vehicle condition, driver status, expenses, account pick-up and delivery details, location, state line crossings, toll road information, etc. In addition, data is automatically recorded by a variety of fixed vehicle sensors.

Q *Can a Vehicle Information System record more than just speed, rpm, and mileage?*

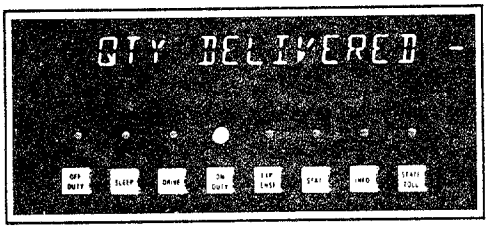
A Yes! Depending on the type of sensors used, a VIS can be expanded to accommodate many sensor inputs. Information on fuel flow, engine temperature, oil pressure, refrigeration temperature, lift gate usage, power take-off, bulk and liquid flow, etc., can be obtained.

THE DRIVER'S FRIEND

Q *Is the Cummins CADEC 300 on-board computer user-friendly?*

A As one driver put it, "it's as easy to use as my telephone." The unit is mounted in the cab in an accessible position. The user-friendly software prompts the driver in plain English to guide his input. The Cummins

CADEC 300 features a 20 character alphanumeric display bright enough to be easily read night or day.



Q *Is the Cummins CADEC 300 accepted by drivers?*

A Drivers like the Cummins CADEC 300 not only because it is user-friendly, but because it also eliminates so much paperwork. It eases the job of recording data for trip reports. It is often presented to the drivers as their small business computer to help them manage the trip and cargo.

Q *How does the Cummins CADEC 300 reduce driver paperwork?*

A The Cummins CADEC 300 can reduce or virtually eliminate driver paperwork by producing detailed trip reports, account pick up and delivery information, over/short/damaged goods reports, expense reports, even a graphic depiction of the DOT drivers log.

Q *Does this mean the driver no longer has to maintain his manual written log?*

A Yes, with some qualification... the DOT has allowed the use of the Cummins CADEC 300 in place of handwritten driver log books for qualified over-the-road fleets.

Q *Can I get help with my state fuel tax reporting?*

A The Cummins CADEC 300 can reduce the clerical cost of preparing state fuel tax reports by documenting all the data you need. Not only will it cost you less to prepare your reports, but the Cummins CADEC 300 will minimize any chance that you miss an opportunity for your full refund.

MANAGEMENT'S FRIEND

Q *What types of information can be obtained with a Cummins CADEC VIS?*

A Information pertaining to safety, operations, maintenance and accounting is available.

Q *How does management benefit?*

A Fleet management is provided with a more effective means of information and control. The Cummins CADEC 300 is a practical, cost effective way of gathering, reporting, and analyzing quantitative trip information immediately upon termination of the trip.

Q *What kind of operational data can I obtain?*

A The Cummins CADEC system can determine pre-trip time, yard time, drive time between customers, arrival and departure times. It calculates items delivered per hour and delay time caused by customers, identifies empty miles by

trip, detects unauthorized stops and measures post-trip time. In addition, driver and clerical paperwork are dramatically reduced.

Q *If driver paperwork is reduced, is some other activity burdened with additional paperwork?*

A No—not with the Cummins CADEC 300. *All* paperwork is reduced substantially. Complete trip data is stored in the removable memory cartridge. When plugged into the Data Link, the information is immediately available to a local or remote computer. Data is gathered more quickly and in greater detail than a Trip Recorder, or by any other means.

Q *What about clerical work—can any time be saved there?*

A Definitely. Redundant clerical operations and intermediate data preparation steps can be eliminated, as well as time delays and clerical errors, because data is entered by the driver and edited by the Cummins CADEC 300 at the source.

Q *Can I single out a particular driver's performance?*

A Yes. By "inputting" variable trip and pick-up and delivery standards, you can compare actual performance against those standards to rate the efficiency of a single driver, terminal or division.

Q *Will I have a more accurate idea of where my trucks are during the trip?*

A Not only will you know where your trucks are traveling, you will also know how far, how fast and at what rpm. This is the type of hard data you need for continuous cost control. It also gives you the tools to manage your fleet, monitor its performance, optimize routing and schedule preventative maintenance.

Q *Regarding engine mistreatment—is it possible to determine a driver's driving and shifting habits?*

A Yes. Engine rpm is shown for given speed categories. This enables you to identify drivers with poor shifting or driving habits, as well as periods of possible excessive stress on the engine.

Q *Can I reduce idling time?*

A Yes! The Cummins CADEC 300 will provide a detailed report showing total time spent idling during each trip. By monitoring and taking corrective action, fleets can generate immediate fuel savings.

Q *Can payroll be linked to a vehicle/driver activity?*

A Yes. Cummins CADEC 300 can measure a driver's hourly activities or trip mileage. System reports can be used to determine payroll.

Q *Can I also find out how much time my driver is taking for coffee breaks, lunches and other breaks?*

A The Cummins CADEC 300 system records all vehicle stops, including those which are not associated with a pick-up or delivery.

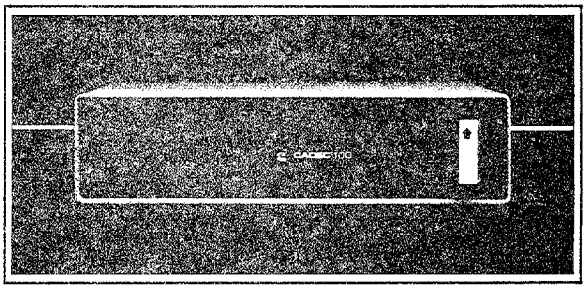
- Overtime Savings
- Reductions in Unauthorized Stops
- Reduced Clerical Work
- Reduced Paperwork
- Reduced Maintenance Costs
- Reduced Losses Associated with Cargo Spoilage
- Reductions in Excess Idling
- Improvements in MPG
- Increases in Driver Productivity
- Optimized Routing
- Accident Reduction
- Reduced Insurance Costs
- Better Customer Service
- Improved Vehicle Utilization through Reduction in Empty Miles
- Reduction of Customer Delays
- Increased Business

Q *There are several Trip Recorders on the market. Is the Cummins CADEC 300 the only complete Vehicle Information System product available?*

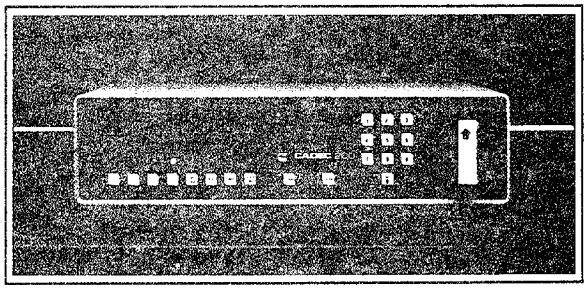
A Yes. The Cummins CADEC 300 represents a new generation of products designed to manage your fleet in today's cost competitive world. Others have introduced "input modules" for their recorders, but this is the only system that can truly address management's need for detailed information and help your drivers in the process.

Q *What if I don't need all of this information?*

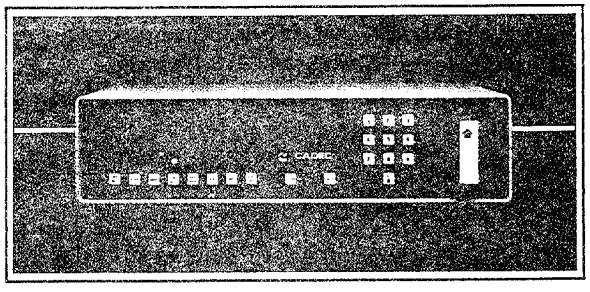
A The Cummins CADEC system is available in three configurations. The CADEC 100 is a Trip Recorder without a key pad and display. It provides information about the trip which can lead to fuel savings and improved maintenance. The CADEC 200 involves the driver to provide detailed information on the trip, fuel usage, taxes, expenses and other items. The CADEC 300 is the complete Vehicle Information System offering the additional savings and safety features associated with driver log management and accident analysis.



CADEC 100



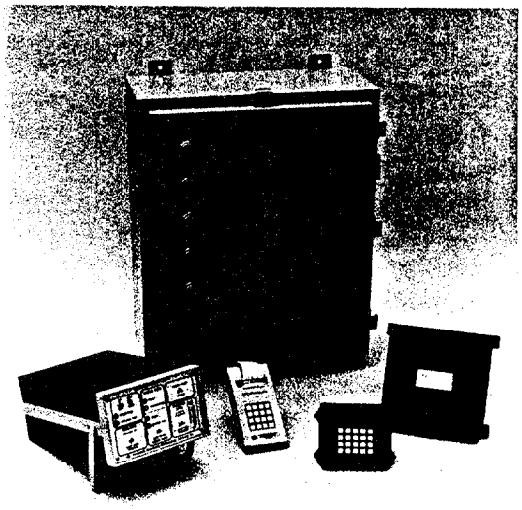
CADEC 200



CADEC 300

ARI PRESENTS
THE FLEET DATA MASTER SYSTEM™

SYSTEM HARDWARE



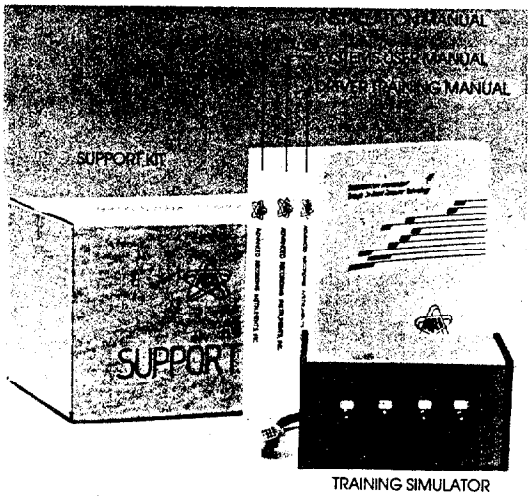
ADVANCED RECORDING
INSTRUMENTS, INC.

- Quick and Easy to Install. Accurate & Reliable.
- Provides vital Driver Activity & Vehicle Operation Information Enabling Additional Control of Fleet Operating Costs
- Thousands of Vehicles Throughout the United States, Canada, and Australia are Equipped with the FLEET DATA MASTER SYSTEM™
- Full 12 Month Warranty. Extended Warranty Service Contract Available.

INCLUDES EVERYTHING YOU NEED TO GET THE JOB DONE

- **On-Board Equipment**
  - Driver Input Unit (DIU)
  - Data Acquisition Unit (DAU)
  - Wiring Harness & Sensors
- **Off-Board Equipment**
  - Data Command Unit (DCU)
  - Data Transfer Unit (DTU)
  - OR
  - Data Transfer Station (DTS)
- **Fleetsum Software**
- **User Manuals**
  - Installation Manual
  - Driver's Manual
  - Software Users Manual

SUPPORT MATERIAL



TRAINING SIMULATOR

TRANSPORTATION MANAGEMENT THROUGH ON-BOARD COMPUTERS

CALL TOLL FREE: 1-800-233-5125

IN WASHINGTON: (509) 922-1052

PRODUCT SPECIFICATION DATA

ON-BOARD EQUIPMENT

DRIVER INPUT UNIT (DIU)

- Dash Mounted
- Driver Prompting
- Lighted Keyboard
- 12 Character Display
- Driver/Trip Activity Keys
- Constant Speed Display

DATA ACQUISITION UNIT (DAU)

- Standard 32K Memory Stores
  Six plus weeks of Trip Data
  Expandable to 96K
- 12 Month Battery Back-Up
- Records Trip Data Each Second
- Calibrated for Individual Engine Specifications.

OFF-BOARD EQUIPMENT

DATA COMMAND UNIT (DCU)

- Handheld Calibration Unit
- Provides a Printed Calibration Record Per Vehicle
- Calibration Features Include:

  Vehicle Identification
  Beginning Odometer
  Time-Date-Day
  Mileage/Speed Calibration
  Minimum Event Identification
  Extended Idling Mile Marker Identification
  Speed Set Point
  RPM Set Point
  HI/LO Water Temperature Set Point
  HI/LO Oil Pressure Set Point

- Individual Calibration can be Changed in a Matter of Minutes.

SUPPORT KIT

- Provides All Material Required To Support Installation

DATA TRANSFER UNIT (DTU)

- Portable AC/DC Rechargeable Unit
- RS232 Electronic Transfer
- Switch Selectable For Use With Computer, Telephone Modem or Direct to Printer

- OR -

DATA TRANSFER STATION (DTS)

- Automated Vehicle Data Transfer
- Transfer of Data From Vehicle in a Matter of Seconds
- Intermediate Storage Does Not Require Dedicated PC
- Constructed For Outdoor Weather Protection
- PC Can Tie into Multiple Data Transfer Stations

TRAINING SIMULATOR: Permits Driver Training in Classroom

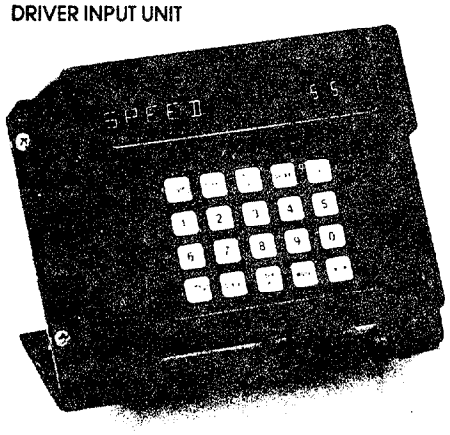
CALL TOLL FREE: 1-800-233-5125

IN WASHINGTON: (509) 922-1052

ARI AUTOMATES THE TRIP REPORT!

ADVANCED RECORDING
INSTRUMENTS, INC.

DRIVER INPUT UNIT



MOUNTS ON THE DASH

THE DRIVER INPUT UNIT (DIU) FEATURES INCLUDE

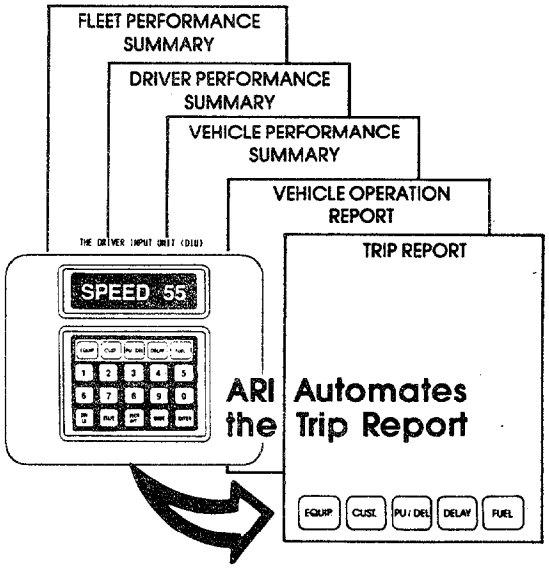
- 12 Digit Alpha/Numeric Display
- 5 Dedicated Driver Input Keys

EQUIP. | CUST. | PU / DEL | DELAY | FUEL

- Driver Identification Input Key Allows Driver To Input I.D. Number
- State Identification Input Key Allows Driver To Input State Code Number and Road Identification Number
- User Option Input Key Allows User to Identify up to 99 Custom Codes
- Mode Key, Driver's Window to Data being recorded in the DAU (RPM, Odometer, Oil Pressure, Water Temperature, Time, etc.)

FLEETSUM REPORTS INCLUDE:

- TRIP REPORT
- VEHICLE OPERATION REPORT
- VEHICLE PERFORMANCE SUMMARY
- DRIVER PERFORMANCE SUMMARY
- FLEET PERFORMANCE SUMMARY



REPORTS THAT ARE EASY TO READ & EASY TO UNDERSTAND

CALL TOLL FREE 1-800-233-5125

IN WASHINGTON (509) 922-1052

SAMPLE REPORTS

TRIP REPORTS CAN BE GENERATED WITHIN MINUTES AFTER YOUR VEHICLE HAS RETURNED

ADVANCED RECORDING INSTRUMENTS
TRIP REPORT

COMPANY - CDG TRUCKING

DRIVER NUMBER....587567744 REPORT DATE..04/01/87 1306
DRIVER NAME..... JOHNSON VEHICLE NUMBER..... 225

EVENT DATE	DRIVER INPUT	DRIVER LOG ACTIVITY	START TIME	STOP TIME	EVENT MILES	ROLLING HOURS	HOURS OVER SPEED	IDLE HOURS	STOP HOURS
	STATE> **	RD> 0	0417						
	MILES>	1							
	RUN TO>	MOSES LAKE	0417						
	EQUIP#>	387	0417						
	DISPATCH #>	1	0418						
	START LOC>	SPO. DIST	0418						
04/01	-		0418	0557	71	1:26	0:03	0:13	0:47
	DELAY TIME>	0:47	0557	0644					
	DELAY CODE>	MEAL							
	CUST#>	TURN POINT MOSES LAKE	0736						
	-		0644	0746	43	0:52	0:01	0:10	0:00
	EQUIP#>	40	0805						
	EXTENDED IDLE>	0:18							
	-		0746	1012	109	2:07	0:03	0:19	0:24
	CUST#>	STORE 255 SPOKANE	1013						
	DELIVER#>	8	1035						
	-		1036	1046	2	0:09	0:00	0:01	0:14
	CUST#>	STORE 288 SPOKANE	1047						
	DELIVER#>	4	1059						
	-		1100	1116	9	0:15	0:00	0:01	0:43
	CUST#>	STORE 290 SPOKANE	1116						
	DELIVER#>	6	1139						
	PICK-UP#>	5	1139						
	DELAY TIME>	0:20	1139	1159					
	DELAY CODE>	COFFEE BRK							
	-		1159	1227	11	0:23	0:00	0:05	----:--
	CUST#>	TURN POINT SPO. DIST	1229						
	FUEL>	42	1235						
	STATE> WA	RD> 90	1238						
	MILES>	245							
	TOTALS				245	5:12	0:07	0:49	2:08
	PERCENTAGES						2.2%	13.6%	

ENDING ODOMETER> 354463

THE TRIP REPORT PROVIDES ALL OF THE VITAL TRIP ACTIVITY INFORMATION:

- Start Time / Arrival Time
- Event & Total Trip Miles
- Event & Total Rolling Hours
- Speed Above Company Set Point
- Idle Time
- Stop Hours
- Warm-up / Cool-down Time
- Separates Each Driver's Activity
- Speed/Idle Percentages per Driver and per Trip
- Customer/Vendor Information

THE VEHICLE OPERATION REPORT HIGHLIGHTS

- Operation of the Vehicle by Each Driver
- Totals Each Driver's Miles
- Totals Engine Hours by Driver
- Totals Time Driver Exceeds RPM Set Point
- Totals Time Driver Exceeds Speed Set Point
- Time That Vehicle Is Operated in
  - LOW — NORMAL — HIGH
    - Oil Pressure
    - Water Temperature

ADVANCED RECORDING INSTRUMENTS
VEHICLE OPERATIONS REPORT

COMPANY - CDG TRUCKING

DRIVER NUMBER.....578567744 REPORT DATE..... 04/01/87 1306
DRIVER NAME..... JOHNSON TOTAL ENGINE HOURS..... 6:01
VEHICLE NUMBER..... 225 HOURS OVER 1800 RPM.. 1.1% 0:04
TOTAL MILES..... 245 HOURS OVER 57 MPH.. 2.2% 0:07
ENDING ODOMETER..... 354463 HOURS OF IDLE..... 13.6% 0:49

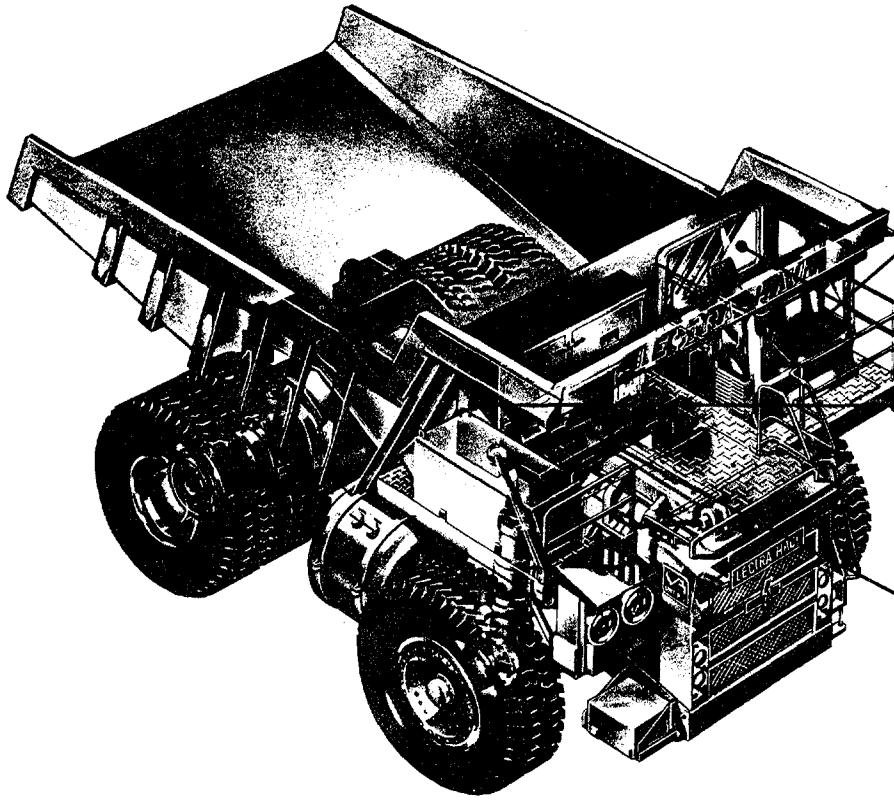
PTO	RPM RANGE	SPEED RANGES 0-24	25-39	40-49	50-54	55-59	60-64	65+	RPM TOTAL
	0-799	1:01	:	:	:	:	:	:	1:01
	800-1199	0:09	0:02	:	:	:	:	:	0:11
	1200-1299	0:02	0:02	:	:	:	:	:	0:04
	1300-1399	0:03	0:04	0:01	:	:	:	:	0:08
	1400-1499	0:04	0:05	0:02	0:05	:	:	:	0:16
	1500-1599	0:02	0:05	0:03	0:56	0:11	:	:	1:17
	1600-1699	0:02	0:07	0:07	0:11	2:24	:	:	2:51
	1700-1799	0:01	0:03	0:05	:	:	:	:	0:09
	1800-1899	0:01	0:01	0:01	0:01	:	:	:	0:04
	1900-1999	:	:	:	:	:	:	:	0:00
	2000-2199	:	:	:	:	:	:	:	0:00
	2200-2499	:	:	:	:	:	:	:	0:00
	2500+	:	:	:	:	:	:	:	0:00
0:00	SPD TOTAL	1:25	0:29	0:19	1:13	2:35	0:00	0:00	6:02

	WATER TEMP			OIL PRESSURE		
RANGE	LOW	NORMAL	HIGH	LOW	NORMAL	HIGH
HR:MN	0:45	5:17	0:00	0:00	5:49	0:13

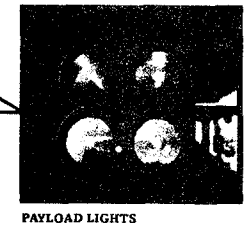
LAST CAL: 03/01/87 1129 LAST PWR.FAIL: 03/17/87 1058 CAL PULSES: 3475

THESE REPORTS CAN ALSO BE GENERATED BY EXCEPTION . . . IF VEHICLE IS OPERATED ABOVE COMPANY PARAMETERS.

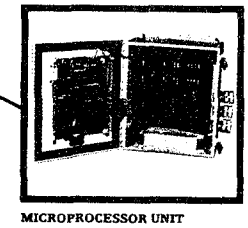
UNIPARS
MONITORING SYSTEMS



CAB DISPLAY AND INPUT MODULE



PAYLOAD LIGHTS



MICROPROCESSOR UNIT

BASIC SYSTEM COMPONENTS

The basic UNIPARS system includes:

CAB DISPLAY AND INPUT MODULE—■ Provides read-out of any monitored function ■ Receives operator input to log truck status ■ Over 4,000 digital codes available ■ RS-232 I/O for accessory printer or radio modem

MICROPROCESSOR UNIT—■ Z80 microprocessor and software ■ 8k memory ■ Time clock ■ Truck wheel revolution counter ■ 7 dedicated analog channels ■ 7 dedicated digital channels ■ 9 digital and 9 analog channels available for optional use ■ Input Sensors: Only high quality materials are used to relate performance data

PAYLOAD LIGHTS—■ Signal full or incomplete loads for shovel / loader operator ■ Display on both sides of the truck

OPTIONAL FEATURES

Telemetry. Your UNIPARS installation may be equipped with telemetry to enable the centralized computer to interrogate the microprocessor for "real time" performance and production reporting.

Warning Device. A cab-mounted warning device can alert the operator of any out-of-limits condition which is noted by the microprocessor.

On-Board Printer. A portable on-board printer is also available to minimize the time required for maintenance trouble-shooting on the diesel engine and the electric drive system.

TURN-KEY INSTALLATION

Unit Rig technicians can perform turn-key installation of UNIPARS system on your fleet during individual hauler servicing. System training is provided to insure that you maximize the benefits that UNIPARS offers. Factory trained technicians are available to provide service support or upgrades for the systems.

UNIPARS PAYS FOR ITSELF

When used to its fullest potential in your mining operations UNIPARS will promptly pay for itself. Your investment in UNIPARS is protected by the same one year warranty which is extended on all Unit Rig manufactured products. To learn how the UNIPARS pay-back potential can benefit your operation, contact the Unit Rig UNIPARS Information Center, Unit Rig & Equipment Co., Tulsa, Oklahoma. Telephone: 1-800-331-3080. In Oklahoma, telephone collect, 1-918-446-5581.

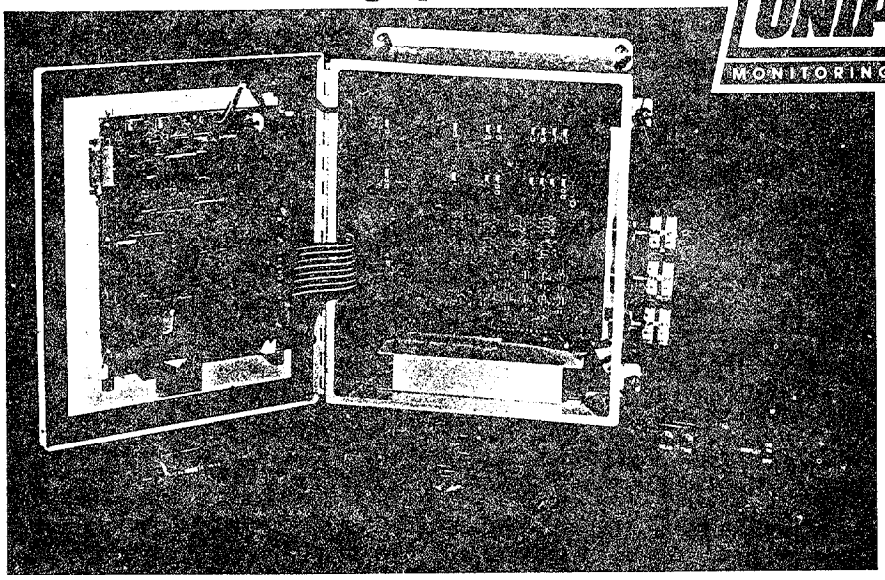
UNIT RIG
A KENDAVIS INDUSTRIES COMPANY

UNIT RIG & EQUIPMENT CO.
P.O. Box 3107
Tulsa, Oklahoma 74101-3107
Telephone: (918) 446-5581 1-800-331-3080
Telex: 46-30099

6-582/8-86

213

UNIPARS® Monitoring System



UNIPARS MONITORING SYSTEMS

UNIT RIG'S ON-BOARD DIAGNOSTIC COMPUTER WILL IMPROVE YOUR HAULAGE FLEET'S OPERATING EFFICIENCY

ACCURATE REPORTING

The UNIPARS® Monitoring and On-Board Weighing System is designed to monitor, retain and report on daily haul truck engine, wheel motor and loading activity. UNIPARS payload weighing accuracy is ± 3% on total daily production.

INDIVIDUAL HAULER ANALYSIS

UNIPARS utilizes microprocessor technology to monitor and report on up to 32 functions of vehicle, engine, wheel motor and load performance. If greater reporting capacity is desired, UNIPARS can readily be expanded to 64 functions. Daily reports will provide your maintenance and production staff with valuable performance data to enable them to more *efficiently* and *effectively manage each haul truck* in your fleet.

UNIPARS can identify potential electrical, mechanical and thermal problems, allowing maintenance personnel to *avert costly breakdowns before they occur,* reducing maintenance expense and minimizing lost production.

TRANSFERRING DATA

The UNIPARS Z80 microprocessor stores up to 8k of data in memory. This data is accessed by down-loading through a cartridge with interface to your personal computer (IBM/PC or Apple IIIC). Once down-loaded to the PC, the information can be analyzed, transmitted via phone modem, printed, organized into report form or stored for future use.

EXTENSIVE 32-INPUT REPORTING

UNIPARS in its standard 32 channel configuration provides information on:
PRODUCTION DATA — ■ Payload Hauled ■ Daily Haul Totals ■ Haul Cycle Time ■ 10-Day Operational Trends

MAINTENANCE DATA

SWITCH SENSORS	ANALOG SENSORS
Engine Alarm Functions	Engine Oil Pressure
Oil Pressure	Engine Water Temperature
Water Temperature	Engine RPM
Crankcase Pressure	Payload Sensor
Dump Body Up Switch	Alternator/Generator Voltage
Hand Brake Switch	Alternator/Generator Current
Service Brake Switch	Electrical Horsepower
Retarder Switch	9 Channels for Optional Input
9 Channels for Optional Input	

REPORTING TO FIT YOUR OPERATION

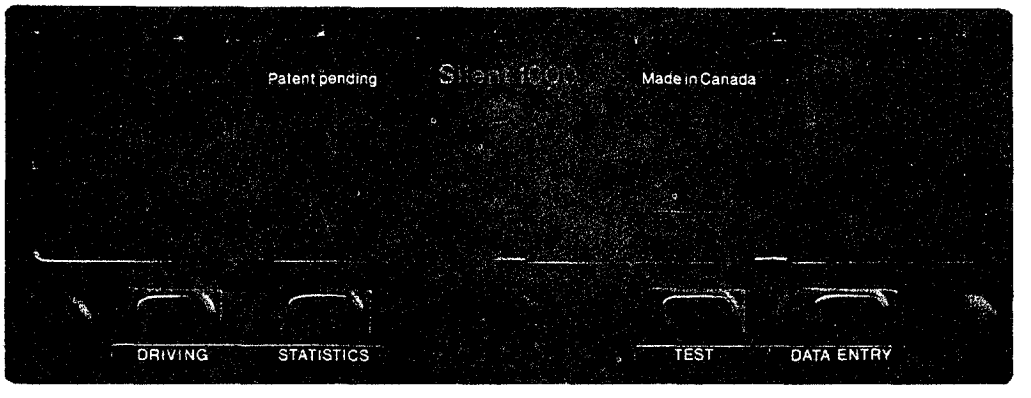
Truck performance and payload reports can be formatted to suit your maintenance, production, and operations planning activities. Through the use of basic language, the UNIPARS software can also be readily expanded to accommodate your growing requirements.

UNIT RIG® UNIT RIG & EQUIPMENT CO.

presenting...

the "SILENT 1000"®

ELECTRONIC TRIP RECORDER



(ACTUAL SIZE)

THE BACKGROUND — Since the introduction of the "Silent 500"® electronic taximeter in 1975, Centrodyne has become North America's largest manufacturer of taximeters with exports to over 30 countries in all five continents of the world. In 1979 Centrodyne began the initial design of the "Silent 1000" ELECTRONIC TRIP RECORDER, applying the same field proven taximeter design approach to the generation, computation, display and analysis of "tachograph" information.

THE CONCEPT — The "SILENT 1000" ELECTRONIC TRIP RECORDER goes beyond merely computing and displaying "tachograph" data — IT COMPLETELY ELIMINATES THE NEED FOR PAPER CHART RECORDING AND INTERPRETATION. Data stored in the "Silent 1000" vehicle mounted unit (VMU) can be displayed and transferred either directly or via a portable data transfer unit (DTU) to a low cost, off-line, micro-computer. The micro-computer is programmed to immediately produce a series of detailed hard copy reports, for the purposes of operational cost control and productivity improvement.

IN CANADA & ELSEWHERE:
Centrodyne Inc.,
3485 THIMENS BLVD
ST LAURENT, MONTREAL, QUE.
CANADA H4R IV5 TEL. (514) 331-8760
TELEX 05-824-659

IN THE U.S.A.
Centrodyne Corp. of America
276 East Allen Street
Winooski, VT 05404
(802) 655-4582

THE VMU — The primary function of the dash-mounted VMU is to store and display up to 240 engine operating hours of trip information which can then be transferred to an off-line computer for further processing. Sensors for rpm, speed, fuel, accidents, and customer defined inputs are optional, depending on type of installation. The VMU comprises two separate display windows, providing a driver selectable digital read-out of either vehicle speed and rpm, or fuel consumption and time of day. The unit is configured to provide the driver with visual and audio alarms when customer defined, preprogrammed limits of speed and rpm are exceeded. Additionally, the unit is equipped with four push buttons which allow for data entry. The two buttons on the right hand side provide for 0-99 codes, and the two buttons on the left hand side enable four digit data to be entered, corresponding to a particular code. Typically, one code might be used for driver ID's, another for border crossings, etc., to a maximum of 100 data entries. At the conclusion of a work-period the following typical statistics for the period may be displayed sequentially in the left and right windows of the display unit:

Distance travelled (mi/km)	743	Road time (hrs and mins)	14.47
Average vehicle speed (mph/kph)	50	Maximum speed (mph/kph)	77
Average rpm	1684	Maximum rpm	1950
Average mpg (lit. per 100km)	6.1	Fuel used (gals/lit)	122
No. of stops	4	Stopped time (hrs and mins)	7.52
(Future growth)	-	Idle time (hrs and mins)	1.04
Time above speed limit (hrs and mins)	-	Time above rpm limit (hrs and mins)	0.56

NOTE: The above statistics may be "blanked-out" at the customer's option.

THE DTU — Data stored in the VMU may be "dumped" into the DTU (up to 64 vehicles) and then transferred to the off-line computer, which is programmed to produce a series of reports. Alternatively, the VMU may be removed from the vehicle and connected directly to the off-line computer.

THE REPORTS — The basic report package comprises: Activity Summaries by driver/by vehicle, Trip Profiles, External Input Data, Accident and Violation reports, and Histograms of speed/rpm/stop-time. An example of a typical Trip Profile, Input Data, and Accident report is shown on the opposite page. As ASCII format is provided for those customers who wish to access the raw data for further processing.

BENEFITS OF THE "SILENT 1000" — Aside from the obvious general benefits of electronic over mechanical systems, such as accuracy, reliability, ease of maintenance, light weight, etc., the "Silent 1000" provides digital displays and alarms to the driver not obtainable from other systems, as well as protected areas of memory for recording accident data. Each individual unit may be configured (via the DTU) for the appropriate parameters for the particular vehicle/trip, i.e. long distance hauling, city deliveries, etc. The necessity and cost associated with interpreting paper graphs is completely eliminated. In addition to encouraging safe driving via the displays and alarms, the potential cost savings in fuel, maintenance, and vehicle utilisation, made feasible by the electronic trip recorder, ensure a rapid pay-back of the initial hardware investment.

TRIP REPORT

CENTRODYNE INC.
3485 THIMENS BLVD.
MONTREAL, QUEBEC
H4R 1V5

DRIVER A.N. Employee
VEHICLE 123456
RUN DATE Jun/17/86

FILE # TRB60617.001
REPORT # 1
PAGE # 1

TRIP PROFILE

DATE/SEGMENT				TIME			PERFORMANCE			
DATE	SEGMENT NUMBER	SEGMENT START	SEGMENT END	ROAD HR MN	STOP HR MN	IDLE HR MN	TRIP DIST	AVG SPEED	AVG RPM	AVG FUEL
					0:04	0:04				
Jun/1	1	15:38	16:45	1:07	0:19	0:01	44	39	1550	6.4
	2	17:04	19:33	2:29	0:18	0:02	131	53	1650	5.8
	3	19:51	2:12	6:21	7:01	0:56	313	49	1650	5.9
Jun/2	4	9:13	14:03	4:50	0:10	0:01	255	53	1800	6.5
TRIP TOTALS/AVERAGES				14:47	7:52	1:04	743	50	1684	6.1

SIGNED IN Jun/1 15:34	ROAD 65%	INPUT DATA	YES
SIGNED OUT Jun/2 14:13	STOP 35%	VIOLATION TYPE	IDLE
PERIOD 22:39	IDLE 5%	VIOLATION TIME	0:56
	ENGINE ON 70%	ACCIDENT	YES

INPUT DATA

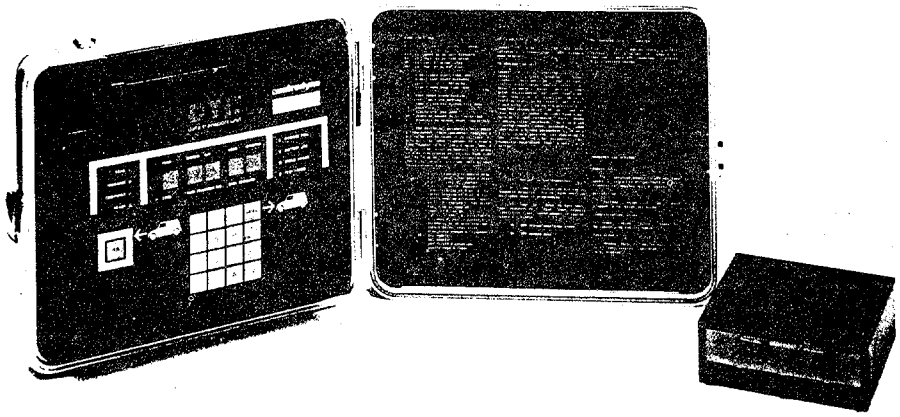
DATE	SEGMENT NUMBER	EVENT START	EVENT	DESCRIPTION	COUNT /TIME	MILE POST
Jun/1	-	15:34	SIGN IN	A.N. Employee	-	0
	-	15:34	PROVINCE/STATE	QUEBEC, CANADA	-	0
	-	-		Trailer Brake Events	1	-
	1	16:41	PROVINCE/STATE	NEW YORK	-	43
	1	-		Trailer Brake Events	56	-
	2	-		Trailer Brake Events	94	-
	3	21:30	PROVINCE/STATE	MASS.	-	258
	3	23:28	PROVINCE/STATE	CONNECTICUT	-	361
Jun/2	3	0:13	PROVINCE/STATE	MASS.	-	384
	3	-		Trailer Brake Events	277	-
	4	9:15	PROVINCE/STATE	NEW YORK	-	488
	4	13:08	PROVINCE/STATE	QUEBEC, CANADA	-	702
	4	14:13	SIGN OUT	A.N. Employee	-	743

ACCIDENT DATA

SENSOR: CRASH SWITCH

DATE	EVENT START	RANGE SECONDS	SPEED READINGS (km/h at 1 second intervals) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Jun/2	13:09	1-20															10	11	12	13	14	16
		21-40	16	14	13	9	5	4	5	5	6	5	7	5	5	6	5	5	5	6	6	5
		41-60	6	5	6	5	5	5	5	5	5	5	4	5	5	5	5	4	5	5	5	*0*
	13:10	1-20	3	5	7	10	13	14	14	14	14	12	11	11	9	10						

**Sensor Triggered Jun/2 at 13:09:59



"SILENT 1000" — SYSTEM COMPONENTS
(EXCLUDING OFF-LINE COMPUTER)

ALARMS —	THRESHOLD —	TYPE —
— Engine Overspeed	— Programmable-Customer Supplied Figure	— Flashing Light/Buzzer
— Vehicle Overspeed	— Programmable-Customer Supplied Figure	— Flashing Light/Buzzer
— Miscellaneous	— Open Door, Etc. 12 Volt Relay Input	— Customer Supplied (2)

TRANSDUCERS	RANGE	— RESOLUTION
— SPEED	0 — 119 mph (191 kph)	— 1 mph/kph
— RPM	0 — 9,999 rpm	— 5 rpm
— FUEL	0 — 40 mpg (L/100 km)	— 0.1 mpg (L/100 km)
RPM AND SPEEDOMETER CALIBRATION:	1-281 pulses per engine revolution 1,200 — 614,400 pulses/mile (km) COMPATIBLE WITH ELECTRONIC SENSORS.	
VMU DIMENSIONS: W x H x L	6.125" (15.56 cm) x 2.25" (5.71 cm) x 5.875" (14.92 cm)	
WEIGHT:	2.2 lbs (1.0 Kg)	
DISPLAYS:	8 seven-segment LED's — digit size 0.56" (14 mm)	
SEALS:	2 unit seals and 1 mounting seal—either locking screw or 9 mm lead seals.	
MOUNTING:	In/On/Against dash Optional two piece kit for remote flush mounted display head.	
TEMPERATURE:	Operating -30°C to 70°C (-22°F to 158°F) Non-operating -40°C to 85°C (-40°F to 185°F)	
POWER:	9 — 16 V DC (Nominal) 20 V DC max. (short term) — 0.5 AMP Nominal - Internal standby battery.	

IN CANADA & ELSEWHERE:
Centrodyne Inc.,
3485 THIMENS BLVD.
ST. LAURENT, MONTREAL, QUE.
CANADA H4R IV5 TEL. (514) 331-8760
TELEX 05-824-659

IN THE U.S.A.:
Centrodyne Corp. of America
276 East Allen Street
Winooski, VT 05404
(802) 655-4582

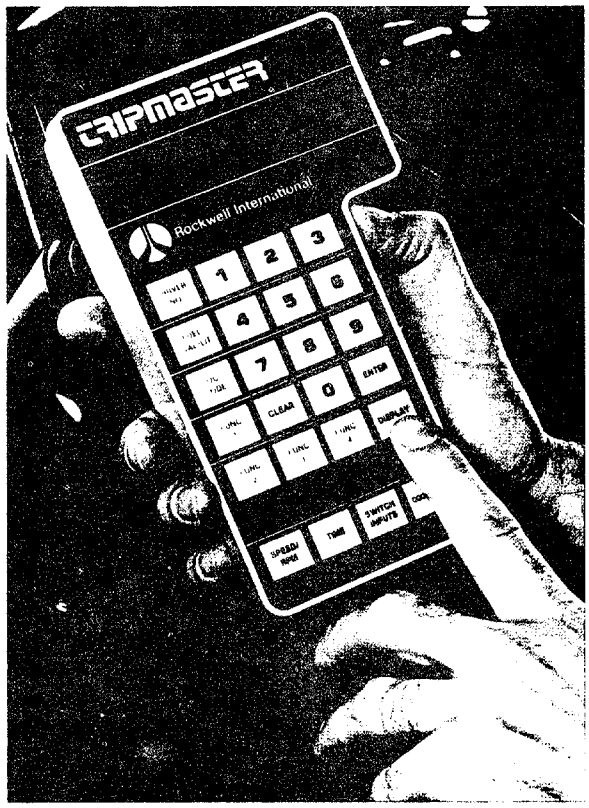
PRINTED IN CANADA

TRIPMASTER® Plus LOGTRAK™

Automatic driver logging option

A New Way To Cut Operating Expenses

Tripmaster® Plus is helping hundreds of fleets achieve greater fuel efficiency, reduced maintenance expense, improved safety, and increased driver productivity. Now, Rockwell announces Logtrak™, a new automatic driver logging option. In addition to the standard trip recording functions, the Logtrak feature dramatically simplifies the entire log keeping process from the driver logbook documentation, to administrative auditing and forecasting of available hours of service.



Tripmaster® Plus With Logtrak™ Fights Administrative Overhead And Expense. The Logtrak feature allows fleet managers to capitalize on the power of computers to streamline hours of service auditing and reporting. And for fleets that qualify, the potential exists to totally eliminate the manual logbook — even further reducing costs while increasing accuracy and safety.

The Logtrak option provides drivers with a means to automatically create electronic logs —simply, quickly and accurately. The system helps drivers eliminate log keeping errors that could reduce their available hours of service. It provides fleet management with precise electronic data to audit manually kept logs, forecast available hours of service, and eliminate costly clerical time required to manually track driver activity and legal compliance.

Fast, Accurate Logs. The system provides extremely precise logs — status changes are accurate to the nearest minute and all vehicle and driver activity is documented. Up to three drivers may be tracked on the same vehicle simultaneously. Sleeper berth periods can be entered and all off-duty time is thoroughly documented. Drivers may display their accumulated hours for the purpose of self-audit or roadside inspection.

Quick Data Extraction And Log Processing.

Tripmaster Logtrak data is quickly formatted into reports upon return to the home terminal. The Direct Extract option enables driver logs, trip reports, and available hours forecast to be printed before the driver parks the vehicle. Management can review their drivers' performance and automatically load the information into fleetwide databases. The system offers unique cost saving opportunities while addressing one of the number one driver complaints — manual log keeping.

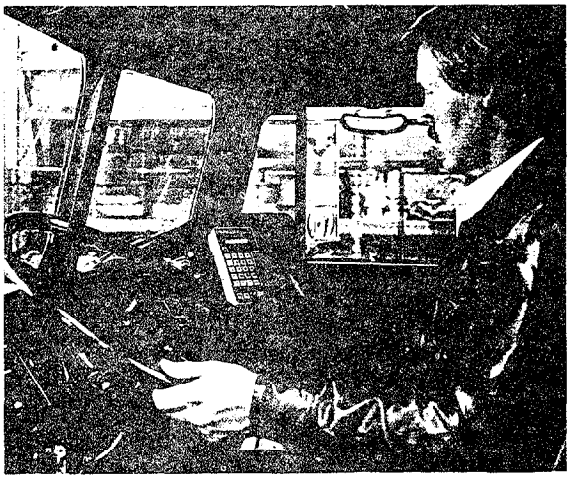
Rockwell

THE LOGTRAK™

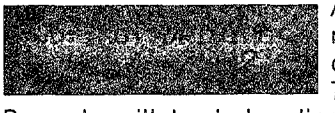
Tripfax® IV Software Reduces Administrative And Clerical Costs. In addition to the complete set of reports offered with Tripfax® III, Tripfax® IV provides powerful software resources to reduce labor associated with driver log management and auditing. This menu-driven, color-enhanced program allows screen display of data for rapid review and analysis. All driver log information can be electronically stored to simplify audit procedures.

Tripfax® IV creates detailed Daily Driver Logs complete with location identification in plain English. The system monitors driver compliance to 7 or 8 day reporting requirements and keeps a running service hours history on each driver. It will create forecasts of available hours for each driver to simplify scheduling and dispatching activity. An exception report is issued upon request that will pinpoint any violations of specific log requirements.

The software operates on an IBM XT® or AT® utilizing DOS 3.1.

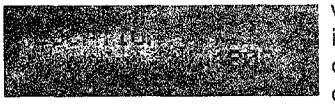


It Works Because It's Simple.

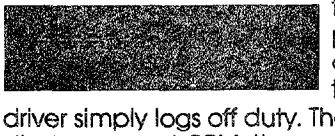


A driver keypad is mounted in the cab connected to a Tripmaster Plus Recorder with Logtrak option. Upon going on duty, a driver identifies who he is, his duty status,

and his location. That's it. From the moment the wheels roll, Logtrak will automatically document duty status changes involving On-duty, Not Driving and Driving time



without further involvement by the driver. At stops, the driver can enter a numeric code to identify where duty status changes take place or he can write them in on



the computerized printout. At the conclusion of his tour of duty, the driver simply logs off duty. The keypad also displays speed, RPM, time and can be used to

enter other pertinent load and operating information.

Monitoring System Has Driver Input

A TRUCK monitoring system developed by Anchron Inc., Santa Clara, CA, adds a keyboard/display option to the familiar on-board computer.

The Data-Com system starts with a microprocessor-based on-board computer which stores information submitted by sensors placed at various points on the truck. Data from the memory unit can be fed into an IBM PC/XT or compatible computer or can later be transferred directly to a serial-type printer. The system can also be adapted for mainframe systems and other PC-type computers.

The hand-held or dashboard-

EQUIPMENT

mounted keyboard/display allows the driver to input information such as state codes, weights, etc. It also provides continuous information regarding mpg (average and instant), oil pressure, rpm, charging system voltage, time and date.

An optional package includes a dash-mounted display of average and instant mpg, giving the driver continuous feedback on fuel efficiency.

Data that can be provided by the system includes individual trip summaries with dates, time, engine hours and engine miles; and detailed trip information such as average mph, idle time, average mph, and violations of limits set by fleet management.

Summary reports provide detailed operating records for each truck, driver, and/or state. Exception summaries—for each truck and/or each driver—indicate violation of warmup, cool down, idle time, rpm and speed parameters set by management.

When used with a compatible computer, the system can also give horizontal bar graph comparisons of rpm violations, fuel usage, idle time and speeding.

Anchron claims that fleets using the Data-Com system have improved fuel economy by more than 10% and, in some cases, as high as 25%.

• Circle 154 on Reader Action Card •

Stemco Instruments Computerized Trip Recording System 7000

Colt Industries

STEMCO INSTRUMENTS

Complete, Accurate and Simple

Stemco Instruments is pleased to introduce the Computerized Trip Recording System 7000. Stemco Instruments CTR 7000 provides the most sophisticated computerized recording system for the transportation manager's needs. Because fleet requirements change, we have developed a modular system that can expand as your needs for information change.

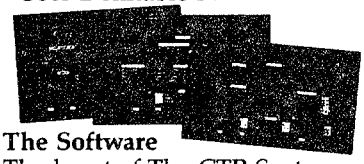
The Data Collector
The Data Collector is of a convenient size and sturdy, tamper resistant construction that can be mounted out of the way. With its ten year battery, it is virtually maintenance free.

The Mobile Memory
The Mobile Memory is designed for rugged use, is tamper resistant and is available with 8K or 16K capacity. Its internal battery will allow data retention for up to ten years.

The Data Entry Terminal
The Data Entry Terminal is designed for extremely convenient operation. The handheld size is easy to integrate into the driver instrumentation area. To be useful to the driver, a data entry terminal must be simple and easy to use. The Stemco Instruments Data Entry Terminal offers:

- Comprehensive Driver Prompts in All Modes
- Full Featured Functionality
- Extensive Menu and Sub Menus
- Alpha and Numeric Entry Ability
- Driver Log

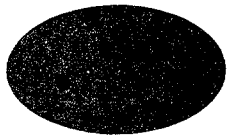
- A Variety of Displays For Driver Information: i.e., Speed, RPM, Time and Date
- User Definable Functions



The Software
The heart of The CTR System 7000 is the software. To allow management the full benefit of the system, the software allows for flexibility and a full range of report options. The System 7000 software offers:

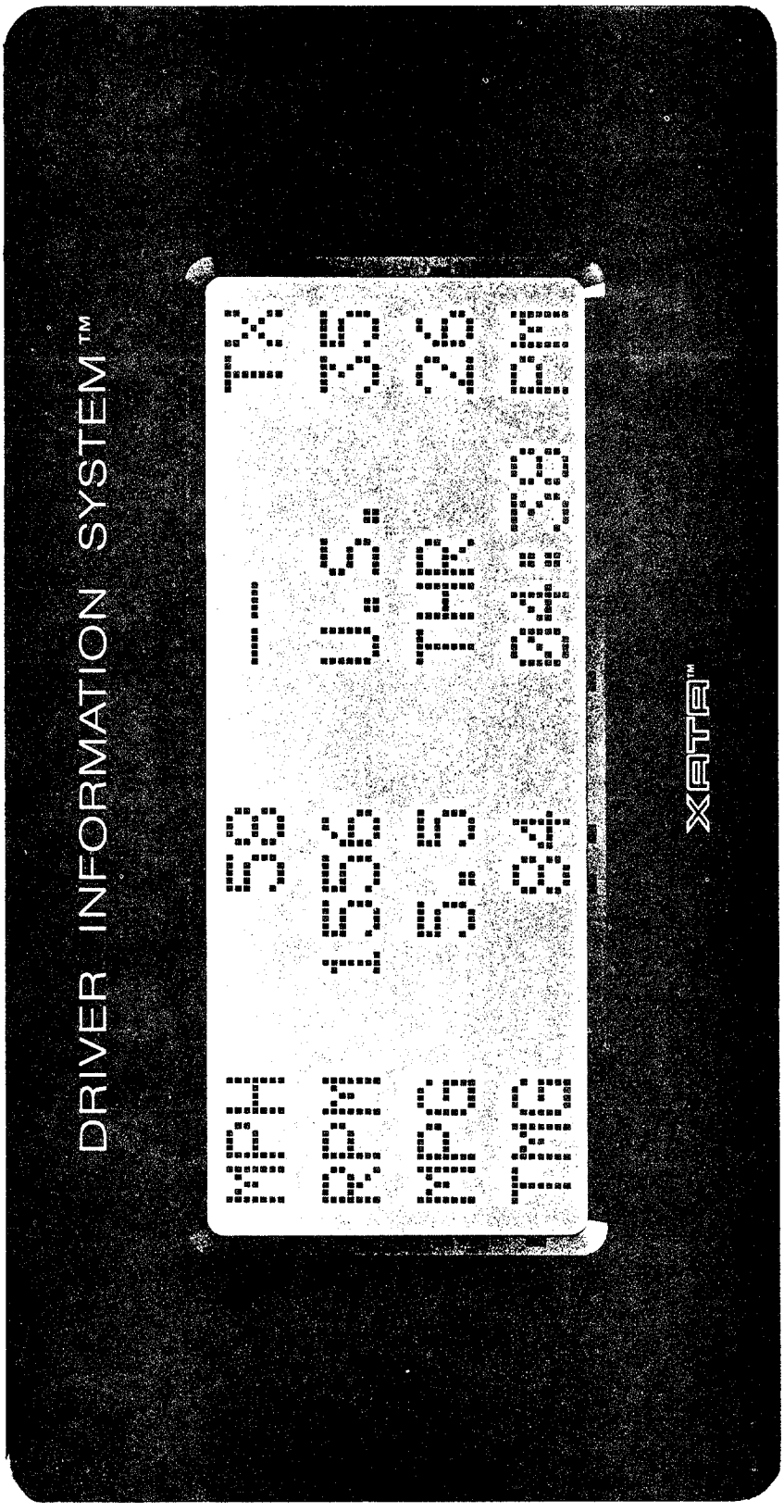
- User Definable Report Formats
- User Definable Exceptions
- Exception Reports to Minimize Management Time Consumption
- A Comprehensive Fleet Information Data Base
- On Line Help Windows For Effective Operation
- User Definable Driver Performance Evaluation System Based Upon As Many As 15 Performance Categories
- Future Portability to Mainframes or Use With Third Party Software
- Data Base Which Allows Performance Comparison Between Terminals, Engine Types, Vehicle Makes, Drivers, etc.
- A Speed, RPM, Brake Matrix to Promote Driver Training
- Status Blocks On Fleet Information Screens Provide Quick Access To Performance Percentages For User Definable Time Periods; Such as, Current Week, Current Month, Previous Month, Year-to-Date, etc.

Flexibility
We cannot know your fleet's future specific needs, so we let you select report content and format. You select driver performance criteria and exception values, even some menu selections on the data entry terminal. The System 7000 gives you the information you need in the format you choose to help you manage your fleet. Invest in state-of-the-art "flexibility". Call us to help you build your Stemco Instruments Computerized Trip Recording System 7000 customized to your fleet needs.



Stemco Instruments
CTRS 7000
P.O. Box 8047
Longview, Texas 75607
Complete, Accurate and Simple
1-800-527-2051
In Texas (214) 643-3236

Pub. No. A7000-3-86 Printed in U.S.A.


DRIVER INFORMATION SYSTEM™
XATA™

#240

The Driver Computer

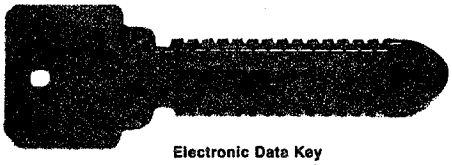
How the Driver Information System Works For YOU

The Driver Information System is an onboard electronic secretary that is designed by the Driver for the Driver. It displays immediate feedback on an easy-to-read touch sensitive screen to assist the Professional Driver's operational decisions. Most paper work is replaced by displaying questions that you answer with convenient "touch entry". The integrated "real time" fuel manager captures fuel consumption as it occurs which allows the Driver and Management to evaluate most conditions that effect fuel economy.

XATA offers the following features in its state-of-the-art Driver Information System:

- Total Team Management. Immediate feedback of operational data to the Driver where it can be improved; not just the capture of data for Fleet Management.
- Intercepts, displays, and updates the MPG every second.
- Computes and displays Ton-Miles-Per-Gallon to give credit for work performed, not just distance traveled.
- Collects route numbers, route miles, and route MPG.
- Collects idle time, warmup time, and idle fuel consumption.
- Speed band analysis of fuel consumption, miles, and MPG.
- Collects all Fuel Tax Reporting information with two simple "touches" per state.
- Collects all Driver Log information to assist with the completion of your log; most of it automatically.
- Utilizes an electronic device in the shape of a key to transfer information from the onboard system to compatible and convenient collection points.
- Evaluates each trip segment and each trip against a performance standard that is automatically maintained for your vehicle, its routes, loads, and specifications.
- Presents the conditions that affect fuel economy for the specific equipment, loads, routes, and speeds.
- Isolates fuel economy factors between two points such as traffic delays, routes, wind, loads, speed, weather, road conditions, etc.
- Establishes accurate mileage and time between points.
- Records empty miles by trip, segment, and percentage of trip.
- Provides the control to evaluate alternate routes for speed, economy, load, and delivery optimization.
- Maintains all onboard performance factors by trip segment as well as instantaneous feedback. Helps evaluate and improve the current trip segment and, thus, the trip.
- Conveniently records all fuel purchases by location, time, ticket number, amount, and cost; including refer fuel purchases.
- Collects all Equipment Hook and Drop locations and times which provides useful equipment utilization and location records.
- Collects all Cargo Pickup and Delivery bills, weights, locations, delays, times, and optional cases or cubes.
- Automatic delivery performance measurement and feedback for each delivery event and for each day's composite delivery performance.
- Captures delay time for docks, equipment, assistance, weather, cargo, repair, etc.
- Collects driver expenses such as food, room, telephone, permits, parts, scale, tollway, and miscellaneous expenses.
- Helpful mileage alarm and time alarm; both visual and audible.
- Built-in fuel theft recognition with time and location approximation.
- Comprehensive accident detail is automatically captured for a second-by-second onboard recall and for hard copy post analysis.
- Convenient calculator capability.
- Driver engineered size and mounting positions.
- Driver engineered large character illuminated display.
- Driver engineered touch data entry.

The Data Collection System

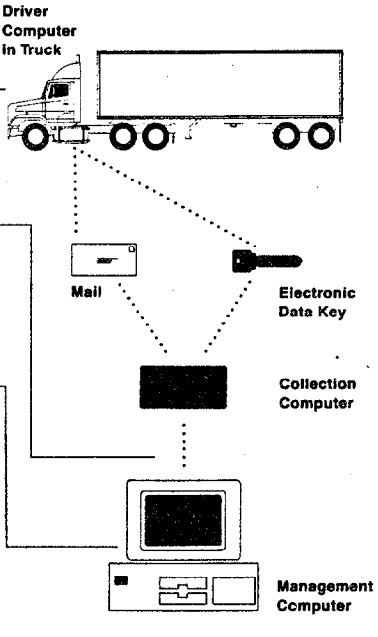


Electronic Data Key
(actual size)

With the simple use of an Electronic Data Key, the driver can transfer information from the Driver Computer to the Collection Computer.

Information is transferred from the Collection Computer to the Management Computer, by telephone lines, direct connect or mail.

Hard copy Team Reports are generated from a standard IBMPC or equivalent.



Driver operating the Driver Computer

To receive more information about the industry's most **friendly** and most **comprehensive** state-of-the-art **Driver Computer System**, contact:

XATA Corporation
500 East Travelers Trail
Burnsville, Minnesota 55337
WATS 800/262-9282 (outside of Minnesota)
or 612/894-3680

Computer Monitors Truck Functions

A DRIVER-ORIENTED on-board computer that monitors about two dozen truck and trip functions is being marketed by Transcom Inc., San Antonio, TX.

The TC-1 computer, which doubles as a data recorder for managers, monitors five primary functions of the engine and warns the driver automatically whenever some operating condition gets out of tolerance. The computer also monitors miles, speed, fuel and other trip planning data and provides analysis of this information when requested by the driver.

Mounted in the cab is a control and display panel that permits the driver to input trip information and select which data he desired to be continuously displayed. The two-line LED panel can display two of the many available functions simultaneously.

For example, miles per gallon and miles per hour can be shown to give the driver exact information on performance.

Alarm features will override whatever is being shown on the display whenever an out-of-tolerance condition occurs. These includes low fuel; high coolant temperature; low oil pressure; low voltage; engine overspeed, and the so-called "event timer," which is a duration of some elapsed time deadline the driver has set into the computer.

Data to be continuously displayed is selected by pressing various keys on the key pad which surrounds the display panel. Some have double usage. For example, one key selects actual mpg. Touch it a second time and the display changes to average mpg achieved thus far on the trip. Similarly, the display of actual mph changes to average mph.

Other data items that can be displayed include time of day; estimated time of arrival at a selected destination; trip time; time ahead of or behind schedule; fuel remaining, fuel used and number of hours to run on remaining fuel; trip miles, and time to destination.

There is also a warning when an estimated 50 miles remains until fuel is exhausted, and another warning when only five miles remains.

The TC-1 computer accepts driver input through a 15-position keypad that is part of the display panel. It may be used to enter such items as fuel purchased, planned mileage to destination and desired redline warning information—for example, engine rpm or highway speed.

A memory element may be added to bring back a record of the trip. Upon arrival at the terminal, the memory can be removed and placed in a high-speed transfer system for analysis and printing by a host computer.

The normal memory element can record as much as 500 hours of running time. An expanded memory element is available that can record up to 900 hours.

The computer's monitoring function is also capable of being expanded, its developers point out. Additional probes can monitor or record such functions as trailer temperature, operation of the cooling unit or axle temperatures.

Cost of the basic computer is under $1,000, with the recording capability more than doubling this price. Additional features, such as audio alarms and memory expansion cards, are available at additional cost.

● Circle 303 on Reader Action Card ●

THE AL 100 CAN HELP YOU...

The AL 100 is the only on-board vehicle information system installed completely on each individual vehicle that requires no other hardware or software support. Each AL 100 system comes complete with Computer Module, Command Module, LED Display, Driver Help Screens and the exclusive onboard AL 100 Printer. The system is Tamper proof and contains its own internal security system.

The AL 100 also features state-of-the-art components and manufacturing techniques that allows our various software packages to be inserted to fit your individual needs.

THE AL 100 STANDS ALONE

IMPLEMENT A MAXIMUM SPEED PROGRAM

1. Reducing allowable speed from 65 mph to 55 mph can decrease required horsepower by more than 100.
2. Decrease fuel consumption as much as 38%.
3. Decrease maintanance as much as 40%.
4. Drivers travel further, more relaxed, require less breaks, and arrive on time more often at controlled speeds.

THE AL 100 HAS AUDIBLE, VISUAL WARNINGS AND PRINTS OUT SPEED VIOLATIONS

DECREASE EXCESSIVE IDLING

1. High sulfur contents in fuels creates an acid that destroys internal components.
2. Idling equals 0 miles per gallon.

THE AL 100 RECORDS ALL EXCESSIVE ENGINE IDLING TIME

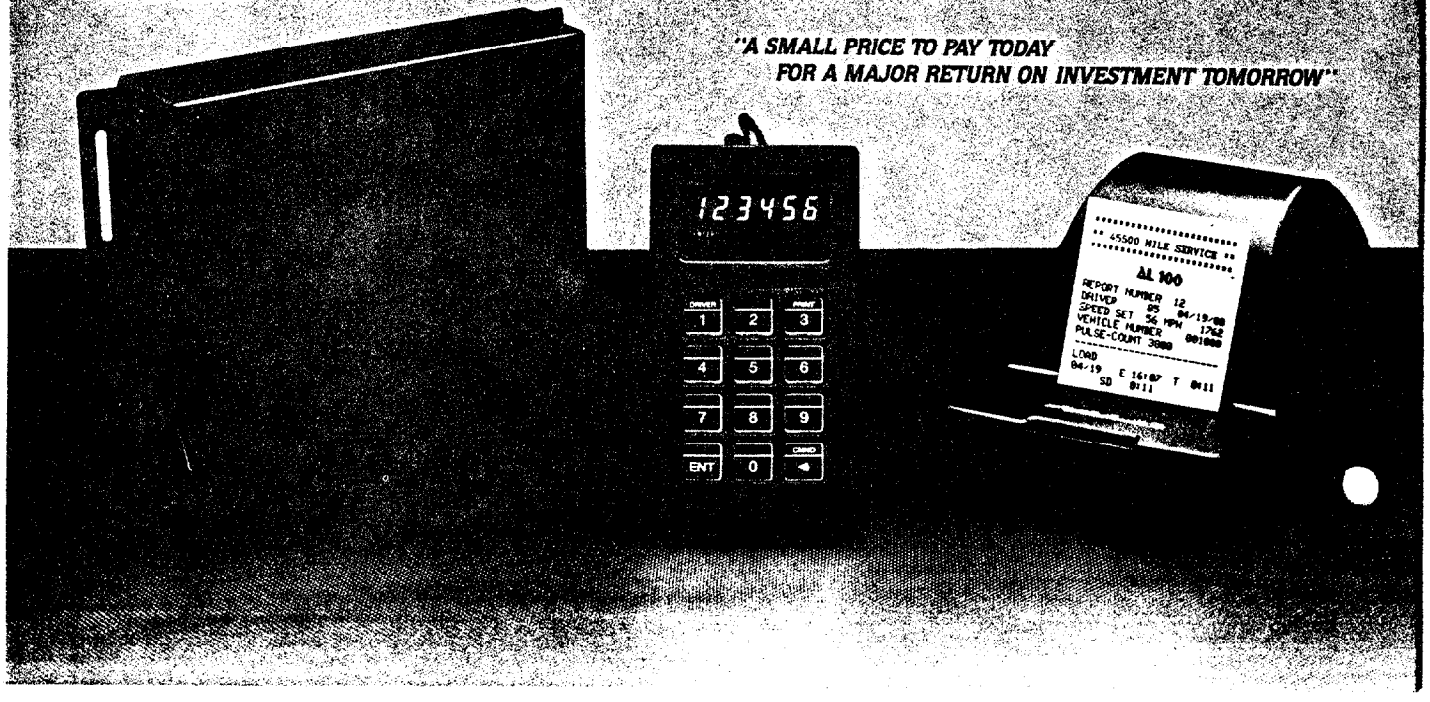
GENERATING A COMPLETE LOG AND INCREASING PRODUCTIVITY

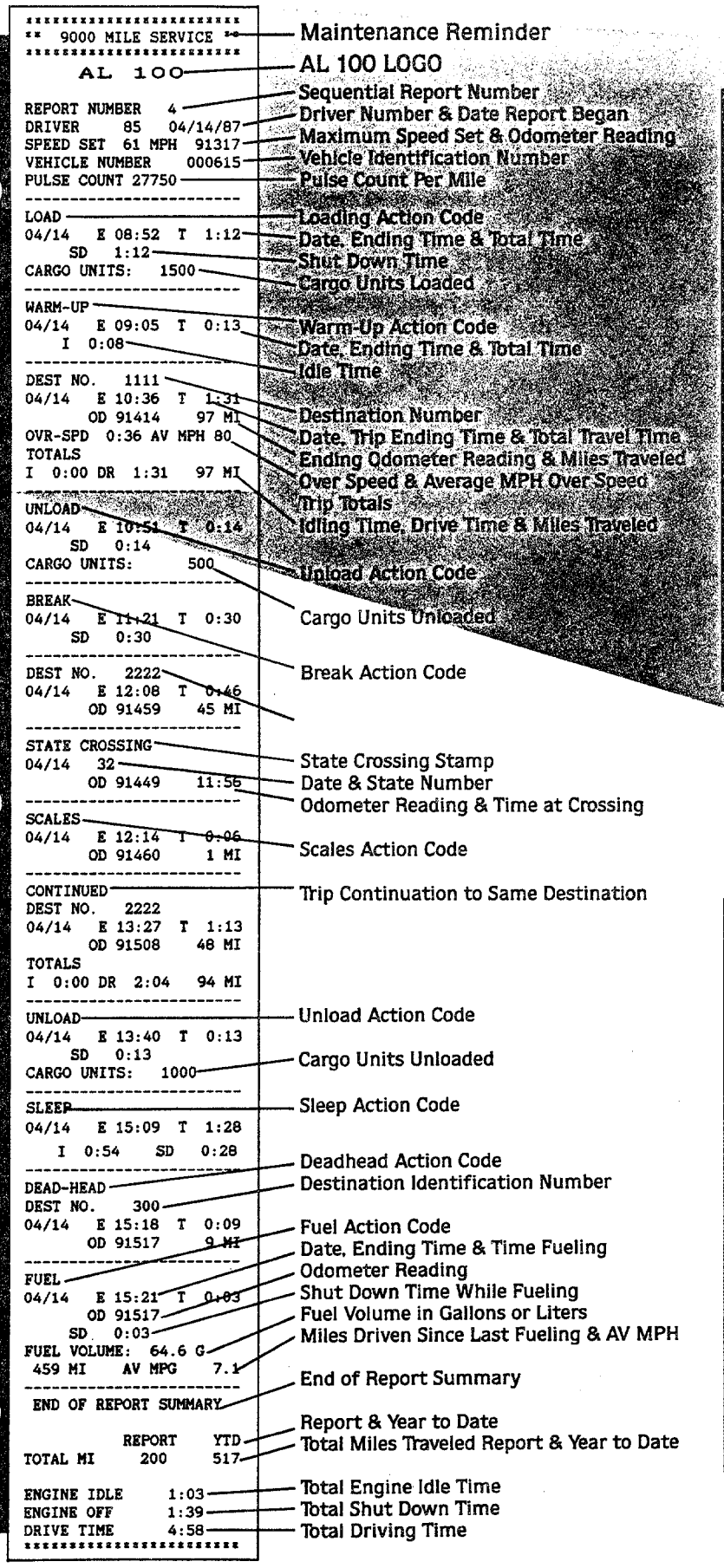
1. The AL 100 takes considerably less time for the driver to enter data than currently required for handwritten manual log entry.
2. The data is accurate, complete, and unbiased for both driver and management.
3. The AL 100 provides simple entry for all categories of vehicle usage.
   - Normal driving with destination identification number
   - Warm-up time
   - Fuel quantity with automatic miles per gallon calculation
   - Loading and quantity loaded
   - Unloading and quantity unloaded
   - Break time
   - Sleeper time
   - Scales time or delays
   - Standby time at accounts
   - Road check or tire check time
   - Deadhead identification with destination number
   - Yard time
   - Service time
   - Maintenance reminder
   - Driver identification number
   - State crossing—time, date and odometer reading stamp

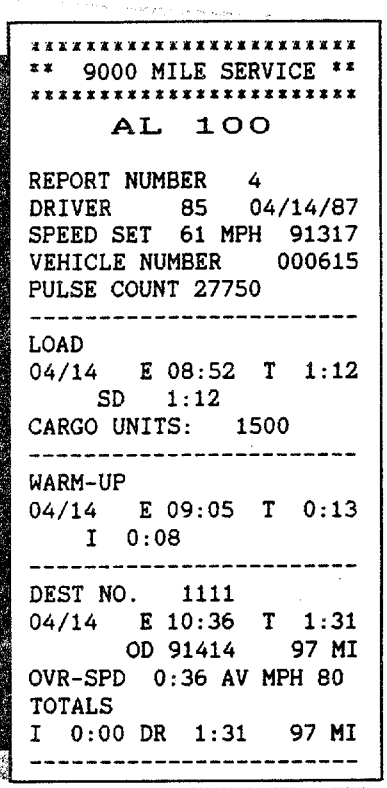
REDUCES INSURANCE COSTS

1. Driver awareness
2. Less speeding
3. Maintenance reminder
4. Vehicle regulation adherence
5. Compliance to company policies and procedures
6. Vehicle accountability

"A SMALL PRICE TO PAY TODAY FOR A MAJOR RETURN ON INVESTMENT TOMORROW"

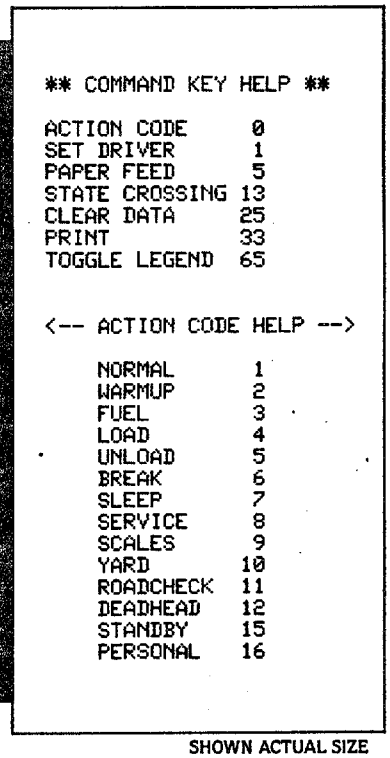






SHOWN ACTUAL SIZE

EASY TO USE— SIMPLE OPERATING PROGRAM MENU



SHOWN ACTUAL SIZE

AL 100 VEHICLE INFORMATION SYSTEM

PRODUCT SPECIFICATION

FEATURE	COMMAND MODULE	COMPUTER MODULE	PRINTER MODULE
SIZE (in inches)	5.04L x 2.72W x 1.78H	7.64L x 4.96W x 1.5H	6.05L x 4.0W x 3.5H
WEIGHT (in pounds)	.52 Lbs.	1.63 Lbs.	1.1 Lbs.
CASE MATERIAL	POLYCARBONATE	19 GA. MILD STEEL	POLYCARBONATE
INTER-CONNECTIONS	6 Ft. to COMPUTER	5 Ft. to POWER/GROUND 8 Ft. to SENSOR	5 Ft. to COMPUTER
COLOR	BLACK	BLACK	BLACK
FCC LICENSE	not required	not required	not required
OPERATING TEMP.	0 to +130°F	0 to +130°F	+33°F to +122°F
NON-CONDENSING OPERATING REL. HUMIDITY	0-95%	0-95%	0-95%
VEHICLE SPEEDS	ALL MPH or ALL KPH	ALL MPH or ALL KPH	ALL MPH or ALL KPH
REAL CLOCK ACCURACY	N/A	4.3 MINUTES Per Month	N/A
DISTANCE ACCURACY	N/A	.998 of VEHICLE'S ODOMETER	.998 of VEHICLE'S ODOMETER

BP BISHOP AUTOMOTIVE PRODUCTS

BPB

1582 N. Batavia, Suite 1 • Orange, California 92667 • Telephone (714) 974-7670 • FAX: (714) 974-7673

ANY COMPANY CAN BENEFIT

Whether you:

- ☐ Currently have a company car/expense reimbursement program,
- ☐ Have had such a program in the past, or
- ☐ Never have compensated employees for their vehicle expenses,

THE MILOG SYSTEM® CAN HELP YOU SAVE MONEY!

A DOLLAR SAVED...

Or, several hundred dollars saved, per employee, per year can add up to a significant addition to the bottom line. If you are not currently taking advantage of this opportunity for savings, The Milog System® can help you start now! If you are, The Milog System® can help you safeguard those savings.

SAVE MONEY BY GIVING YOUR EMPLOYEES A RAISE

The savings generated by The Milog System® effectively allow you to give your employees a net increase in take home pay without increasing your costs.

DON'T GET CAUGHT WITH YOUR RISK UP

With the introduction of the new rules you are assured of either higher costs, or increased risks. Depending on your automobile policy these risks could be substantially increased for both you and your employees if adequate records are not maintained.

THE RISK

The risk in increased taxes (and penalties and interest) due to a lost mileage deduction could easily amount to $1,000 or more in additional costs per employee each year.

HASSLE FREE SOLUTION

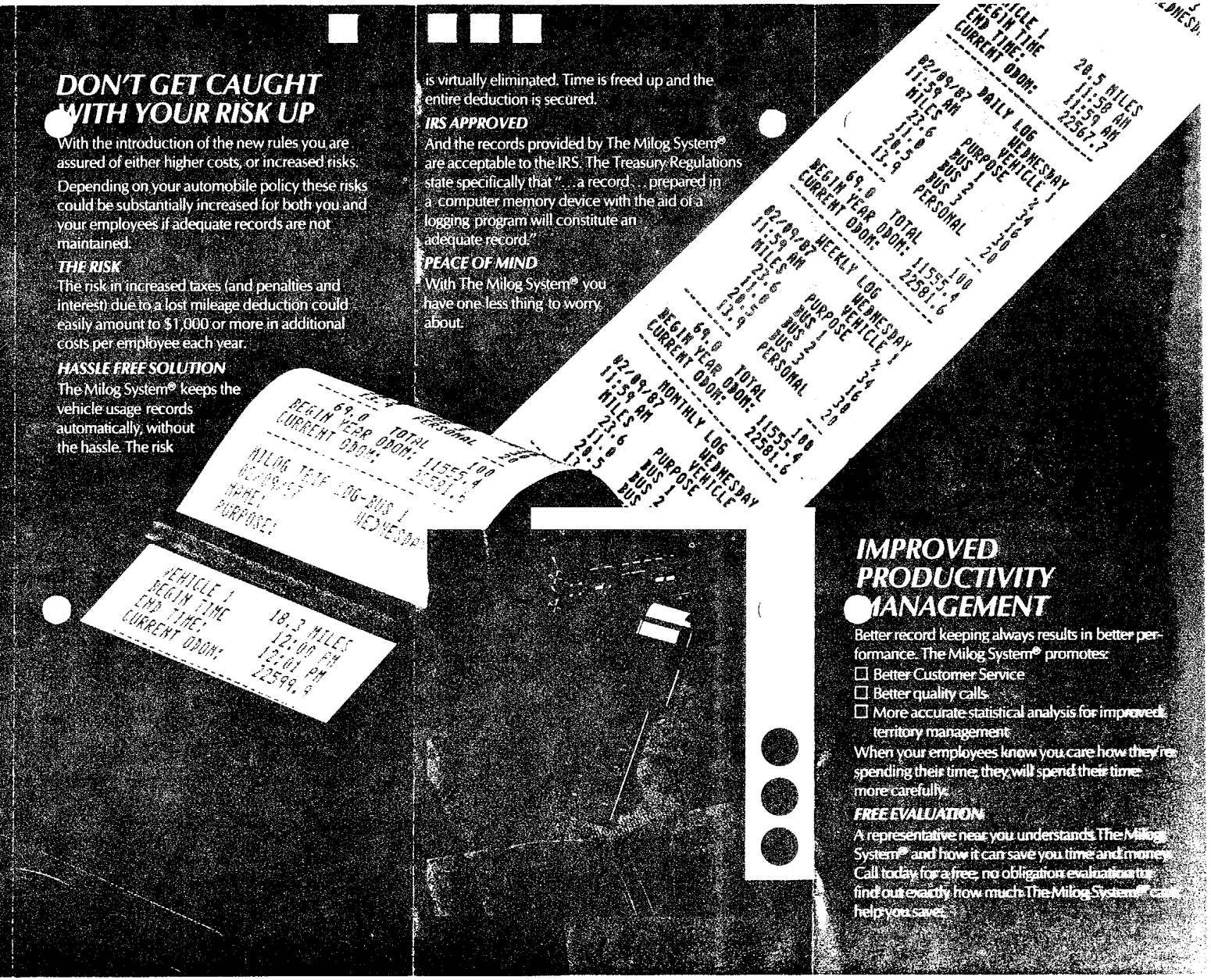
The Milog System® keeps the vehicle usage records automatically, without the hassle. The risk is virtually eliminated. Time is freed up and the entire deduction is secured.

IRS APPROVED

And the records provided by The Milog System® are acceptable to the IRS. The Treasury Regulations state specifically that "...a record...prepared in a computer memory device with the aid of a logging program will constitute an adequate record."

PEACE OF MIND

With The Milog System® you have one less thing to worry about.



IMPROVED PRODUCTIVITY MANAGEMENT

Better record keeping always results in better performance. The Milog System® promotes:

- ☐ Better Customer Service
- ☐ Better quality calls
- ☐ More accurate statistical analysis for improved territory management

When your employees know you care how they're spending their time, they will spend their time more carefully.

FREE EVALUATION

A representative near you understands The Milog System® and how it can save you time and money. Call today for a free, no obligation evaluation to find out exactly how much The Milog System® can help you save.

FEATURES

- NONVOLATILE MEMORY—internal lithium battery preserves data in case of power failure
- MULTI-VEHICLE CAPABILITY—keeps records for up to three vehicles
- DETAILED TRIP LOGS with odometer reading, begin and end times, miles, date, and trip purpose
- TENTH MILE ACCURACY
- AUTOMATIC SUMMARIES—daily, weekly, monthly, quarterly and yearly
- REAL TIME CLOCK AND CALENDAR
- BUILT IN DOT MATRIX IMPACT PRINTER (Not Thermal)
- STANDARD CASH REGISTER PAPER
- TOUGH ABS PLASTIC CASE
- EASY TO INSTALL
- ONE YEAR PARTS AND LABOR WARRANTY

USER SELECTABLE OPTIONS

- Fiscal Year End
- Automatic or On-Demand Trip Logs
- Begin Year and Current Odometer Readings
- Driver Interface or No Driver Interface
- Miles or Kilometers
- Date Displayed MM/DD/YY or DD/MM/YY
- Optional Weekly and Quarterly Summaries

Distributed by

Printed in U.S.A.

C-12.2

MILOG®

BUS 1

BUS 2

BUS 3

GAL

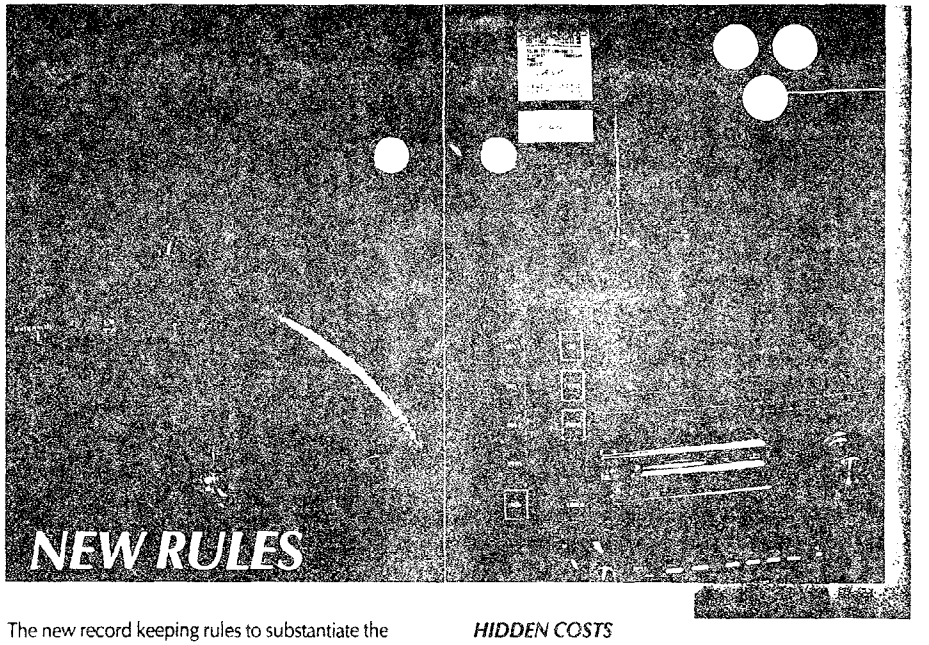
CLOCK

PRINT

HOW TO:

- ☐ SAVE TIME
- ☐ ELIMINATE RISK
- ☐ REDUCE HASSLES
- ☐ INCREASE PRODUCTIVITY
- ☐ INCREASE EMPLOYEE TAKE HOME PAY

AND SAVE MONEY IN THE PROCESS...



NEW RULES

The new record keeping rules to substantiate the business use of vehicles are stringent. The new regulations require:

1. The date,
2. The number of miles driven, and
3. The purpose of the trip
4. For each use of the vehicle
5. Recorded at, or near, the time of usage.

The rules are clear...but compliance is difficult...

THE PROBLEM

This created a problem for companies. To remove this record keeping burden many companies took the easy way out (easy for the company but not for the employee who still has to maintain the same records). These companies did away with their company cars or eliminated their expense reimbursement program and now pay the employee additional "income" to offset the loss.

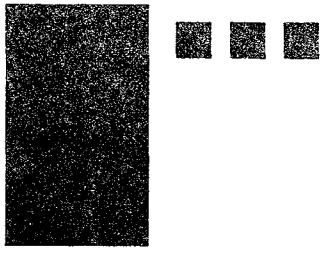
Not only did this create a burden for employees but it also created hidden costs for both employee and employer.

HIDDEN COSTS

These costs, which could amount to hundreds of dollars per employee per year, are incurred whether or not the company or the employee ever get audited.

HASSLE FREE SOLUTION

Must you settle for a solution that costs your company more money? The Milog System® gives you the best of both worlds by automatically keeping the necessary records. Both the company and the employee take advantage of the significant savings (both taxes and other savings) available through a company car or expense reimbursement program.



Appendix D. Vehicle Navigation Systems; Selected Literature

Truck Tracker (228).....D-1

Nav Com (246).....D-2

Omnitracs (254).....D-3

Etack Navigator (270).....D-4

Ariz. 284

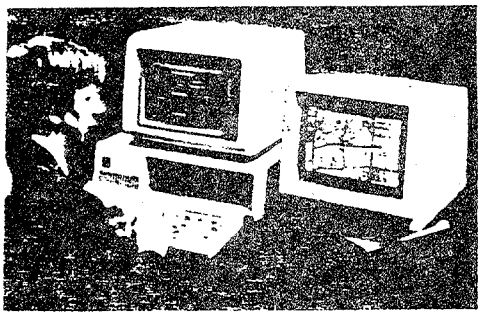
Truck tracker is claimed to locate vehicles to within 60 to 100 ft. Range of the Vehicle Tracking System, which uses the federal government's Loran C network, depends on the type of onboard communications equipment a fleet uses. System includes cab-mounted Loran C receiver and transmitter, control console with custom software, and a monitor that displays maps to pinpoint vehicle location. **Idata Systems, Glenview, Ill.**

285

SYSTEM LOCATES VEHICLES

A Deer Park, NY, communications firm has developed an Automatic Vehicle Locating System that it says is a practical, cost-effective tool for locating, communicating with and managing fleet vehicles.

The system has been designed by NAV-COM Inc., a Magnavox subsidiary, for use by a wide range of fleet types, including high-value and critical or dangerous cargo transportation.



NAV-COM Inc. has developed a computerized system for locating, tracking and communicating with fleet vehicles.

The system consists of a processor and position sensors in each vehicle, connected via radio with a central control computer normally located at the dispatcher's office, where locations of all vehicles are shown on a color digital map display.

Vehicle locations, status and other pertinent data can also be displayed in tabular form, giving fleet managers useful data for further analysis, according to company spokesmen. Software is tailored to provide information in its most useful form.

The position of a vehicle is continually calculated using precise "dead reckoning" techniques, spokesmen say, taking automatic inputs from the truck's speedometer and heading sensor. Unlike other vehicle locating techniques, the system need not be dependent upon radio-navigation signals from land-based transmitters which, spokesmen note, are often subject to error and disruption.

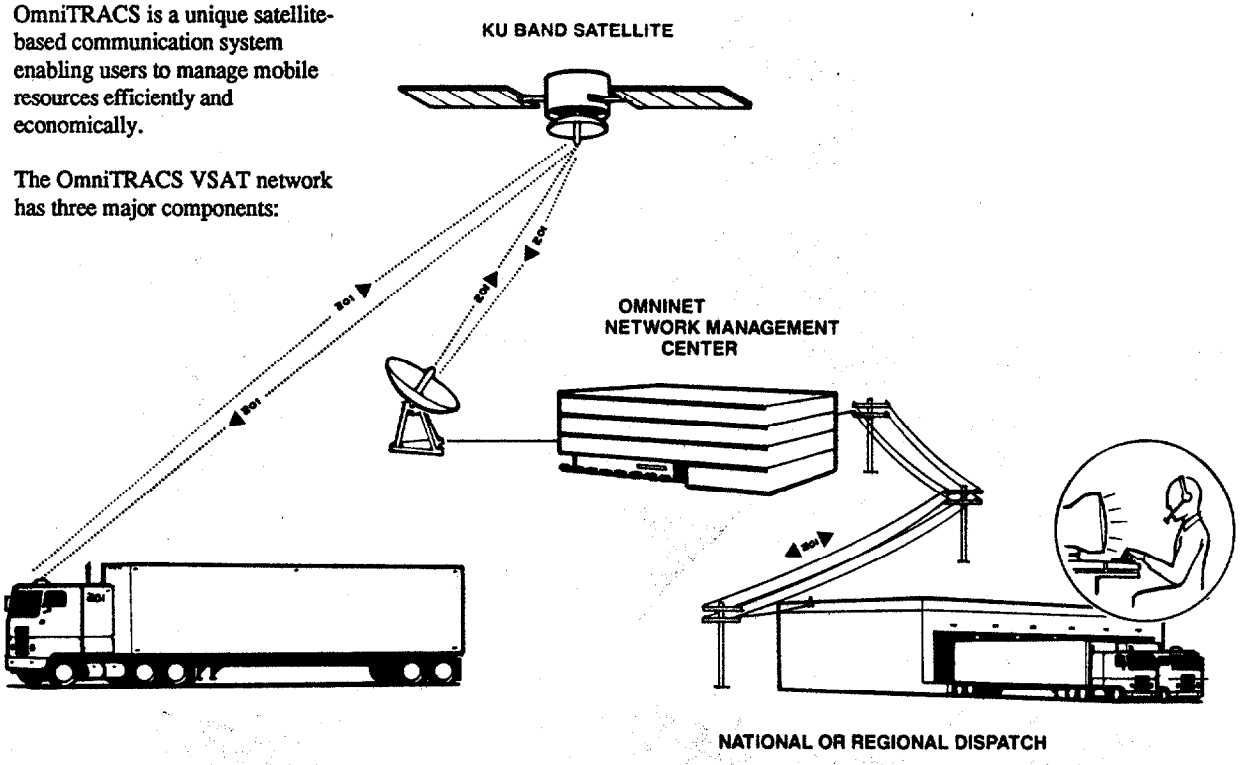
Vehicle position is tracked without reference to any external sources, and position data can be periodically recalibrated using signals from navigational satellites or other sources, depending on the needs of a particular fleet. A video mapping display can also be fitted in the vehicle, showing its actual position relative to streets and landmarks.

Circle 128 on Reader Action Card

OMNITRACS

OmniTRACS is a unique satellite-based communication system enabling users to manage mobile resources efficiently and economically.

The OmniTRACS VSAT network has three major components:

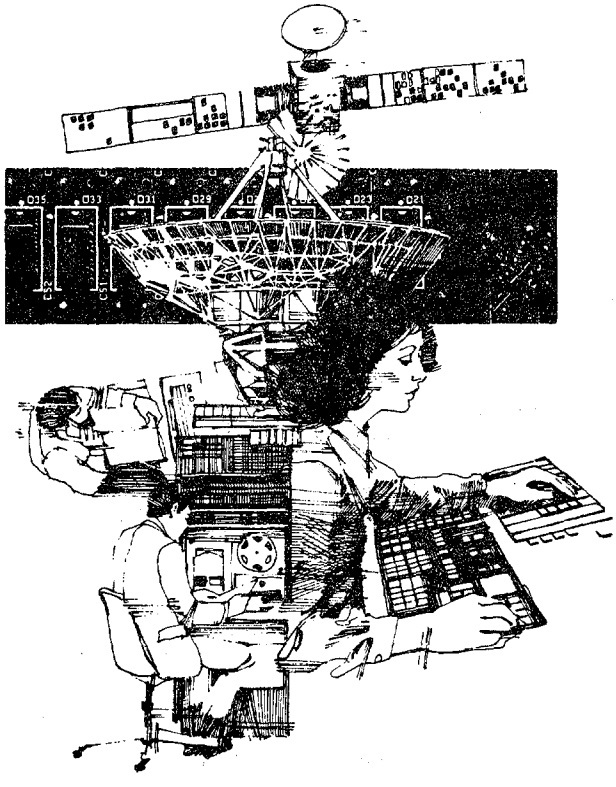


1. A Network Management Facility (NMF) which controls and monitors the OmniTRACS network. The NMF, located in Los Angeles, California with backup facilities located in San Diego, California, consists of a computer facility, message switching and processing equipment, and a satellite earth station to transmit and receive customer messages.

2. Two Ku-band transponders aboard GTE Spacenet's GSTAR I satellite located at 103° west longitude.

3. Two-way mobile and transportable OmniTRACS VSATs (Very Small Aperture Terminals).

The OmniTRACS mobile and transportable VSAT network features two-way data messaging, position reporting, fleet broadcasting, call accounting and message confirmation. The service provides users with an unprecedented range of features in a variety of cost-effective packages.



OmniTRACS features:

Nationwide. Covers the continental United States, including metropolitan and rural areas. No other commercial system is offering similar coverage in North America.

Existing satellites. Uses fully protected Ku-band transponders on existing geostationary satellites which have been operational for many years. There is no risk of satellite hardware failure in-orbit and no dependence on future launches.

Two-way. Allows dispatcher or driver to initiate or respond to preformatted or free-form messages. Emergency, group and fleet-wide messages are also available. Most importantly, it provides a positive acknowledgement of each message sent, ensuring the sender of a successful transmission.

Data communication. Uses computer terminals for message creation and response. Unlike traditional voice systems, messages are received by computer in a fraction of the time it takes for dictation of the same information, and can be stored for convenient viewing or later recall.

Demand for data communication systems has increased as the needs of mobile users have expanded and changed. The desire for greater speed and accuracy in mobile communications, the need to access information stored in computer databases, improvements desired in response time from the field, system security and privacy, and the need for preformatted and storable messages are some of the advantages that the OmniTRACS data communication system provides.

Position reporting. Satellite-aided Loran-C position information is available to the dispatcher after a message is sent to a mobile unit. It may also be provided on a scheduled basis or on demand.

By using the Ku-band satellite as a slave Loran-C station, the satellite-aided Loran-C provides highly accurate position information. This information is beneficial in vehicle management, such as ad-hoc dispatching, scheduling of shipments, vehicle arrival time management, accident location, recovery in the event of hijacking, and many other emergency and non-emergency situations.

Service. Encompasses a range of equipment lease and purchase options, and a commitment to service at every level of customer involvement from training through customized system support.

APPLICATIONS & BENEFIT

There are numerous applications for the OmniTRACS mobile satellite communication system. Any organization or company with a fleet of mobile vehicles will derive notable benefits from the system. From public safety and transportation, to disaster relief and emergency communications, the OmniTRACS system provides economic and safety benefits for a variety of applications.

Public Safety:

Perhaps the most important application of the OmniTRACS system is in the area of public safety. Fire, police and emergency medical organizations using the OmniTRACS system improve their ability to respond and communicate during emergency situations.

While fighting a fire in a remote area, a team of firefighters can remain in constant communication with their base, relaying vital information that may save land and lives. A police officer can request emergency assistance or check a suspect license number, in any area of the United States with the OmniTRACS system. An emergency medical team can transmit vital medical information from a remote area or while enroute to a hospital, and access the medical history of a patient with speed and accuracy.

In emergency situations, when lives may be at stake, it is imperative that the communication system be reliable and accurate. The OmniTRACS data transmission system provides the reliability and accuracy demanded by the public safety industry. Users eliminate the risk of missing vital information by sending and receiving messages in data form. In addition, all messages can be stored for later recall.

The system is not meant to replace voice communications, but rather to enhance the current systems and provide accurate relay of information anywhere in the country.

Public Utilities:

The need for communication with vehicles servicing public utilities such as water, power, and telephone is apparent in major metropolitan areas as well as small rural towns. The ability to convey information via satellite from field to base and vice versa allows for efficient servicing of the public even in the most remote areas of the country.

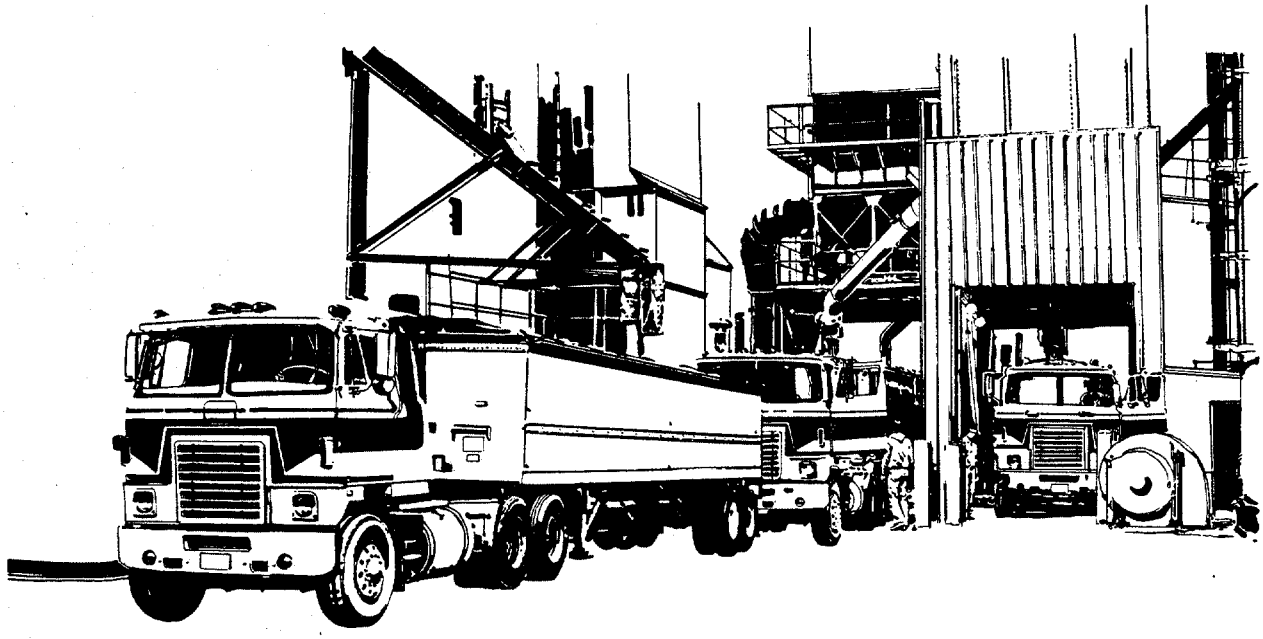
In addition to using the OmniTRACS system for mobile applications in the public utility sector, fixed applications are also appropriate. For example, by placing transportable VSAT terminals at strategic locations along a river or aqueduct, water flow information can be transmitted quickly and accurately, without the need for human interaction. The flexibility of the OmniTRACS system from mobile to transportable applications makes it a valuable tool for public utility companies across the country.

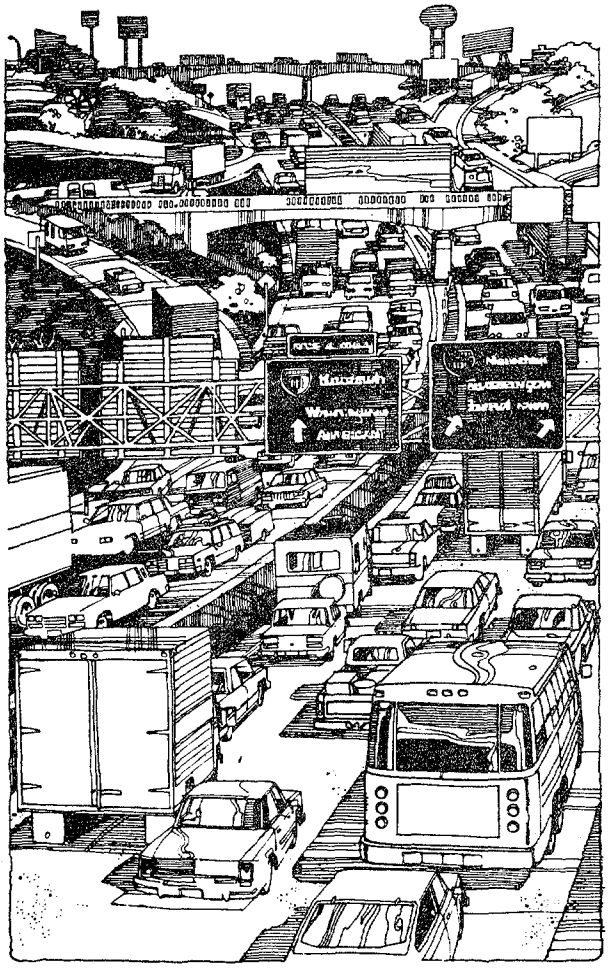
Transportation:

The transportation industry has an increasingly acute need for mobile communications on a nationwide basis. Companies involved in public transit, trucking, railroads, marine transport, and aviation require communication with and tracking of their mobile fleets. The OmniTRACS system provides a cost-effective answer to the needs of the transportation industry. Two key factors make the system cost effective: the mode of the communication (data) and the unlimited range of the system.

Because the OmniTRACS system uses data messages to communicate information, the cost per message is significantly less than voice transmissions. The time spent sending and receiving messages is decreased, thus saving money at both the driver and dispatch levels. In addition, the unlimited transmission range of the system allows for messages to be sent enroute, which eliminates unnecessary stops.

Of particular interest to the transportation industry is the ability of the OmniTRACS system to track vehicles, specifically those carrying hazardous materials, weapons or petroleum. The cargo's value, coupled with the risks involved, requires constant surveillance of the truck, train, or aircraft. The OmniTRACS system provides position reporting of vehicles on demand or at predetermined intervals.





Disaster Communication:

In the event of earthquake, flood or other major disaster, the OmniTRACS satellite system will remain operational, while land-based communication systems may become inoperable. The system could be the key to keeping information flowing from the location of the disaster.

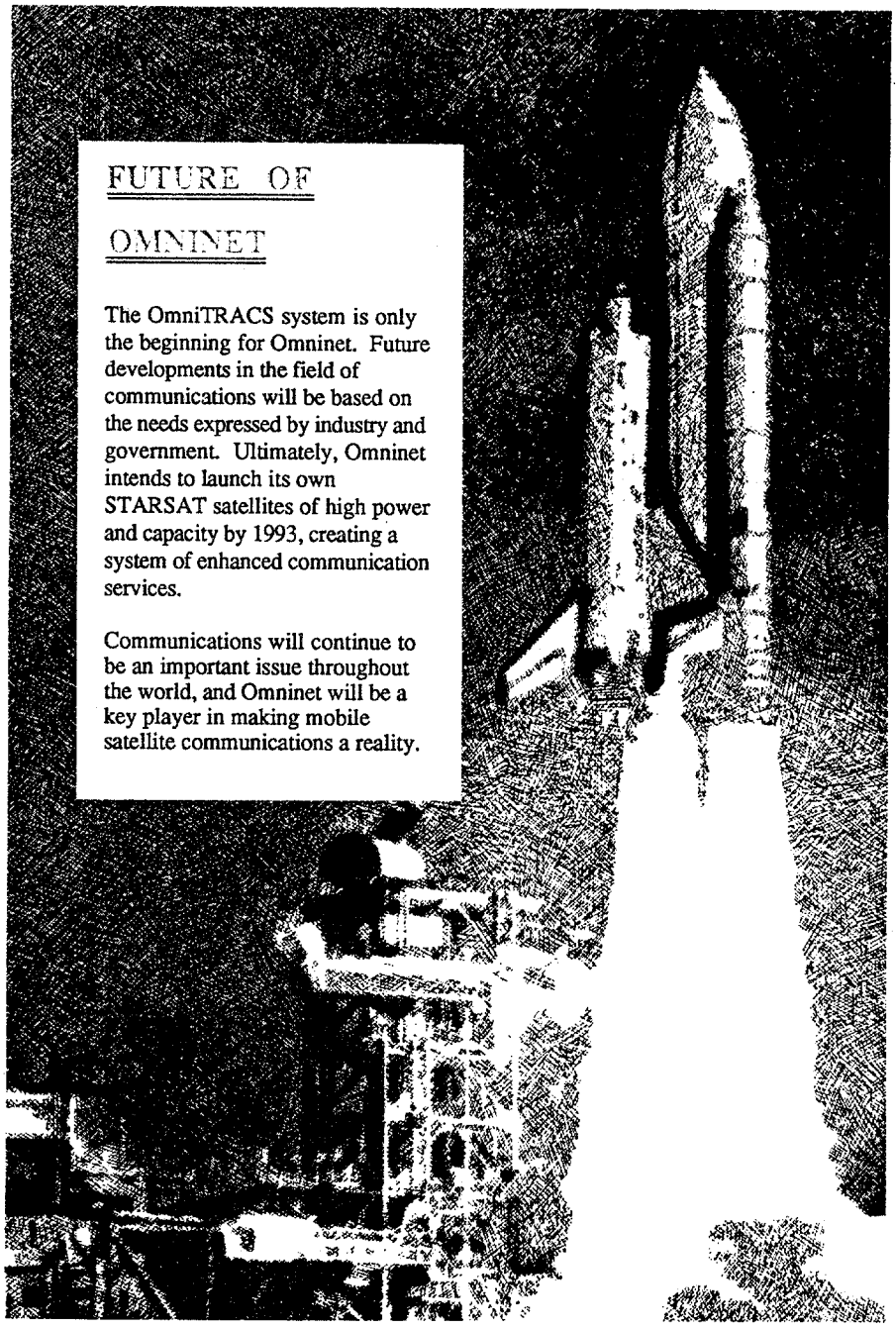
Vehicle Location:

The sheer number of government and private industry vehicles travelling across the country make it difficult to monitor the location of each vehicle at a specific time. The OmniTRACS position reporting system allows a dispatcher to locate any vehicle at any time with the desired level of accuracy. This feature is beneficial for day-to-day monitoring of a fleet, as well as locating a vehicle that has been stolen or involved in an accident. Recovery of valuable merchandise and equipment is possible by using the OmniTRACS system.

Balance of Trade:

"Made in the U.S.A." is a key issue today. As the world clamors for state-of-the-art in communications, it is crucial that the U.S. maintain its dominant position in development and implementation of new technologies. Satellite communications appears to be the next era in communications technology; therefore it is important for the United States to be at the forefront of development.

The OmniTRACS system is the first in a line of many new technologies to come in the area of satellite communications. The United States, as a world leader in the area of communications technology, cannot afford to delay the development of systems like OmniTRACS or we may lose the dominant position and allow others to take the lead in the international market.



FUTURE OF OMNINET

The OmniTRACS system is only the beginning for Omninet. Future developments in the field of communications will be based on the needs expressed by industry and government. Ultimately, Omninet intends to launch its own STARSAT satellites of high power and capacity by 1993, creating a system of enhanced communication services.

Communications will continue to be an important issue throughout the world, and Omninet will be a key player in making mobile satellite communications a reality.

The majority shareholder of Omninet Corporation is Standard Tool and Die Company (STADCO) of Los Angeles, California, with over 90% of current sales volume resulting from government contracts. Under the leadership of Izak P. Nazarian, Chairman of the Board and CEO, STADCO is a large diversified corporation which manufactures customized high-precision large components, parts and manufacturing tools for the aerospace and aircraft industries, energy, communications and industrial companies.

STADCO was founded in 1945 and currently employs over 300 people in a facility consisting of 250,000 square feet of temperature-controlled manufacturing areas located on eight acres of company-owned property in the heart of downtown Los Angeles. STADCO has built a highly respected reputation for quality and reliability of products, precision engineering and promptness of service. STADCO, under contract to Morton Thiokol, is currently involved in remachining all NASA Shuttle solid rocket booster "O" rings. Among other clients, the following are noteworthy: Boeing, Lockheed, General Dynamics, Raytheon, RCA, GM Hughes, Rockwell, General Electric, Martin Marietta, United Technologies and Westinghouse Electric.

OMNINET CORPORATION
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Los Angeles, CA 90016-4496
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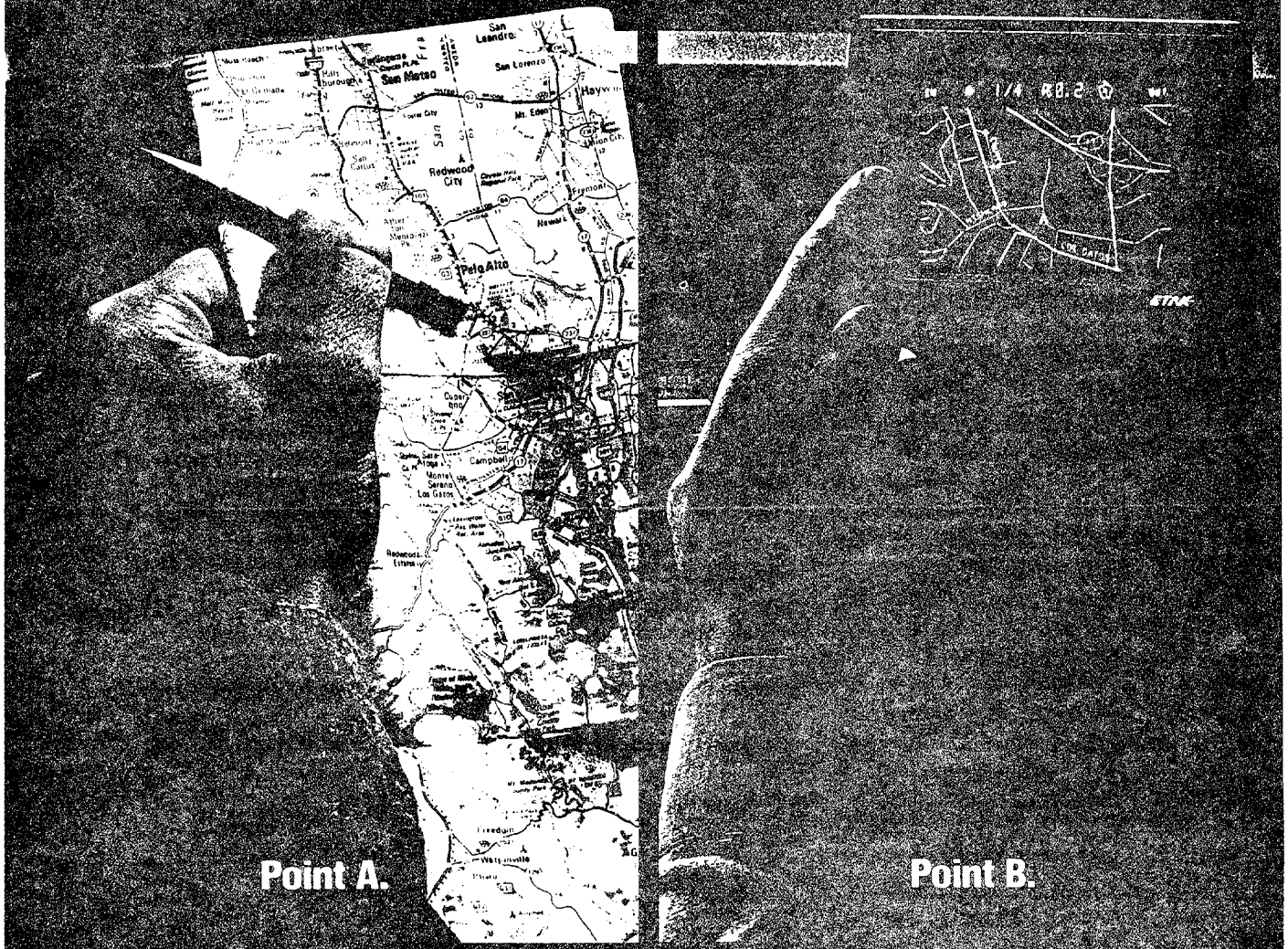
TeleFAX: (213)937-0186
TELEX: 170023 OMNI UT

ETAK

The ETAK NAVIGATOR.™

There are just two points we'd like to make about this incredible new navigation system.



Point A.

Point B.

The ETAK NAVIGATOR. Drive down driving costs.

Point A: Where we are today.

When the first motor vehicle was built nearly a hundred years ago, it had a very simple purpose: to move people, goods, and services from where they were, Point A, to where they needed to be, Point B—more quickly, more economically, and more profitably.

But somewhere on the route from Point A to Point B, something happened. Millions of vehicles quickly filled thousands of miles of roadway. Traffic congestion became the rule, rather than the exception. And driving often became a frustrating confusion of paper maps, incomprehensible directions, wasted time and gas, late or missed appointments. The result? Lost business opportunities and reduced profits.

Point B: Where we're going.

The introduction of this incredible new vehicle navigation system, the ETAK NAVIGATOR,™ is about to change the face of commercial transportation forever.

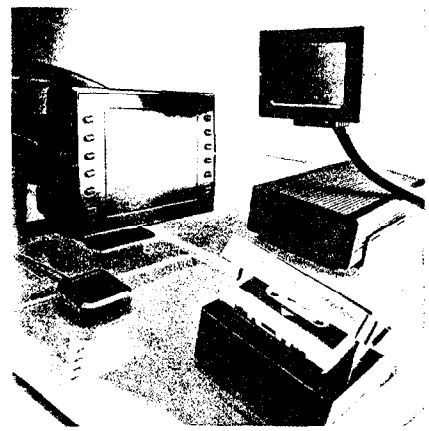
The NAVIGATOR™ takes the form of a small but rugged monitor mounted within easy view of the driver. Electronic maps, called ETAKMAPs,™ are displayed on the screen, continuously showing the vehicle's exact position.

Enter a destination.

A few simple button pushes and the driver enters the street address of a destination. Automatically, a blinking star indicates the location of that destination. With the NAVIGATOR, finding an efficient route to the next stop or appointment is as simple as driving toward the destination star.

View the city—or the smallest street.

One button push and a driver can zoom in for a close-up of the current vehicle location, with street names clearly indicated. Or the driver can zoom out for a metropolitan overview, with the vehicle location and destination still displayed. By selecting the desired zoom level, the driver can quickly see a specially tailored map that clearly shows the information needed to find a destination easily and efficiently.



SPECIFICATIONS

POWER CONSUMPTION
- 12v, 36 watts—operating
- 12v, 12 watts—standby

DISPLAY
- Model 700, 7 inch screen (diagonal)
- Model 450, 4½ inch screen (diagonal)
- Vector graphic display
- 1024H x 770V resolution
- Automatic brightness control
- Antiglare screen

TAPE DRIVE
- 5" x 2¾" x 3¾" 80 ips

ELECTRONICS PACKAGE
- 12½" x 7" x 4"

COMPASS
- Solid state flux-gate magnetic sensor

NAVIGATION TECHNIQUE
- Dead reckoning, augmented with map correlation

AVERAGE POSITIONAL ACCURACY
- Within 50 feet

MAP SCALE
- Variable from ¼ mile to 10 miles

Never get lost.

In a quick glance at the NAVIGATOR display, a driver can instantly see the correct vehicle location and the location of his destination. Never before has it been this easy for drivers to get from Point A to Point B. With the NAVIGATOR, **they'll never get lost again.**

New capabilities for your NAVIGATOR system.

Today's NAVIGATOR provides the foundation for even greater fleet productivity improvements in the future. ETAKMAPs, which store information that makes the NAVIGATOR function, will be revised periodically to incorporate newly built roads as well as new features and functions for the NAVIGATOR.

ETAK also plans to offer a vehicle location system for use in fleet dispatch centers. In this system, information is transmitted from NAVIGATOR-equipped vehicles to a dispatch center, where a large map display shows the position, directional heading, and working status of each fleet vehicle. Two-way digital communication will allow dispatch instructions to be efficiently transmitted directly to the NAVIGATOR screen.

And since the NAVIGATORs you buy today are fully compatible with the planned vehicle location system, there's no need to wait to start experiencing productivity increases from your NAVIGATOR system.

Increase fleet productivity.

The NAVIGATOR is a significant technological breakthrough which allows for greater commercial fleet productivity. By making it easy once again to get from Point A to Point B, the NAVIGATOR increases driver efficiency. That means lower vehicle operating costs. More stops during the course of a day. And more profit for the business owner. When you look at its low unit cost, and the productivity increases that will result, justifying the NAVIGATOR will prove as easy as using it.

The ETAK NAVIGATOR. Find out for yourself just how easy it is to increase profits by using the NAVIGATOR.

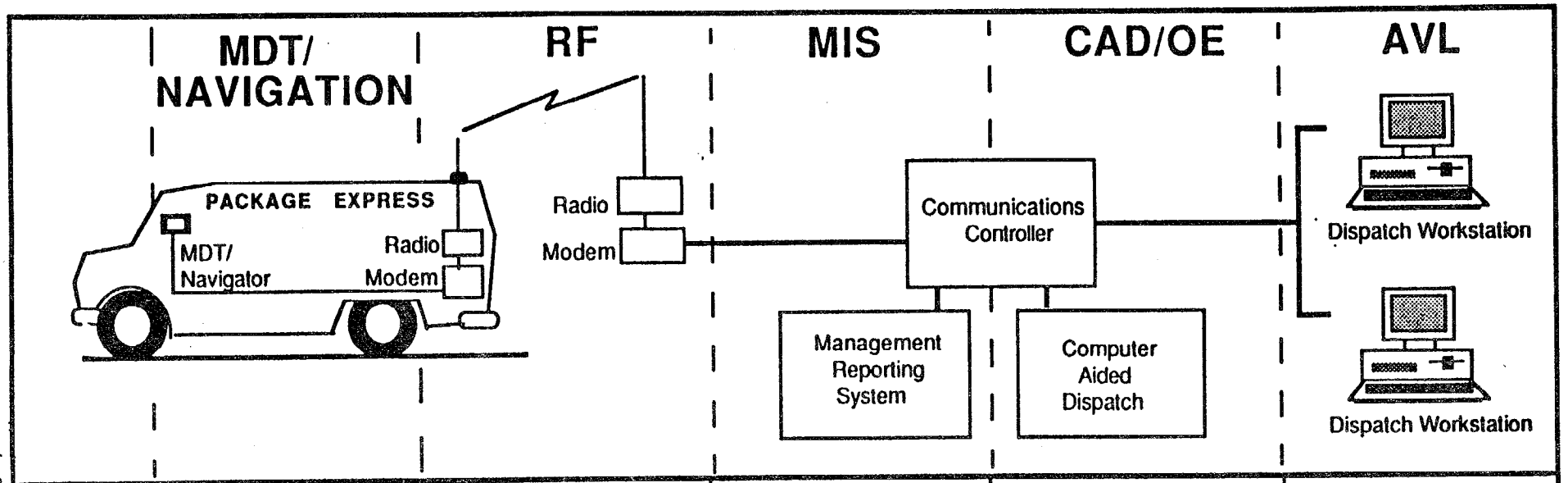
Ask your dealer for a test drive today.

ETAK

1455 Adams Drive
Menlo Park, CA 94025

ETAK

Fleet Management System Overview



	MDT/ NAVIGATION	RF	MIS	CAD/OE	AVL
Functions	• Digital Messaging • Driver guidance to destination locations	• Digital Communications	• Summary management reports • Detailed driver activity reports	• Customer call taking • Interface to Order Entry or Trace/Track System	• Address matching • Vehicle Location Information
Benefits	• Improves service response time • Increases driver efficiency • Increases staffing flexibility	• Allows more communications on same channel • Eliminates waiting for open channels	• Fleet productivity improvements • Increases management control	• Increases dispatcher productivity • Streamlines accounting activity	• Increases dispatcher productivity • Reduces dispatch mistakes

FUNCTIONAL DESCRIPTION

1. AUTOMATIC VEHICLE LOCATION FUNCTIONS

- Vehicle Tracking
  - Shows location of vehicles on map display
  - Vehicle identifier and vehicle class indicated
  - Vehicle position shown on correct street
  - Frequency of position update configured to meet customer requirement for accuracy
  - Number of vehicles tracked is effectively unlimited

- Vehicle Status Monitoring
  - Status codes from drivers shown on map display
  - Vehicle symbols color-coded by status
  - Detailed vehicle and dispatch information available on command

2. COMPUTER-AIDED DISPATCH FUNCTIONS

- Customer Call Taking
  - Call information input screen
  - Automatic transfer of call information from call taker workstation to dispatcher workstation
  - Automatic creation of dispatch file log
  - All transactions time-stamped and date-stamped

- Electronic Map Display
  - Variable zoom map with pan and center commands
  - Highly detailed, accurate street map display
  - Rapid response to map display commands

- Address Matching
  - Simple address entry scheme
  - Rapidly locates selected address
  - Quickly draws map showing dispatch location and closest available vehicles

- Digital Dispatching
  - Information shown on map aids dispatcher decision making
  - Destination locations and text messages can be sent to vehicles as digital messages

3. MOBILE DATA TERMINAL FUNCTIONS

- Receive Dispatch Instructions
  - Destination location, call codes, and text messages are displayed on Navigator screen
  - Audio signal when message received
  - Message buffering
- Send Status Information
  - User defined status codes
  - Unlimited number of status messages

4. VEHICLE NAVIGATION FUNCTIONS

- Map Display for Drivers
  - Vehicle position shown accurately on electronic map display
  - Helps drivers find efficient routes in unfamiliar areas
- Destination Location Display
  - Unfamiliar destinations can be quickly displayed on map by entering street address or by receiving message from dispatcher
  - Common destinations can be stored for instant retrieval

5. MANAGEMENT REPORTS

- Standard Reports
  - Dispatch report shows complete history of each dispatch, including response time
  - Vehicle activity report summarizes daily activity for each vehicle
- Customized Reports
  - Transaction file log allows numerous customized reports to be generated
  - Vehicle location log allows vehicle routes to be analyzed and reconstructed

Etak

DIGITAL MAP PRODUCTS

Etak ®1 -- The Digital Map Company

Etak is a worldwide leader in digital mapping and digital map technology. The company is actively developing complete, up-to-date digital street maps of the United States and Western Europe. These maps are available for a wide variety of applications, ranging from geographic information systems and facilities management to paper map publishing and vehicle navigation.

Etak MapBase™2 -- An Off-the-Shelf Digital Street Map

MapBase is the foundation for Etak's digital map products. It provides highly accurate map data, including street locations (accurate to within 50 feet), street names, addresses, and other information. Current coverage includes over 75% of the metropolitan areas of the U.S. MapBase is available in standard interchange formats for use in mapping software systems sold by ESRI, Intergraph, Synercom, and others.

EtakMaps ™2 -- Maps for use with Etak Software

EtakMaps contain specially formatted map data for use with other Etak software products. While MapBase offers map data in a simple interchange format, EtakMaps stores the same data in a proprietary, highly compressed format suitable for extremely fast retrieval in a variety of applications. EtakMaps are available for use with Etak's products and are combined with navigation software for use in the Navigator ®1, Etak's vehicle navigation system.

Appendix E. Vehicle Tracking Systems; Selected Literature

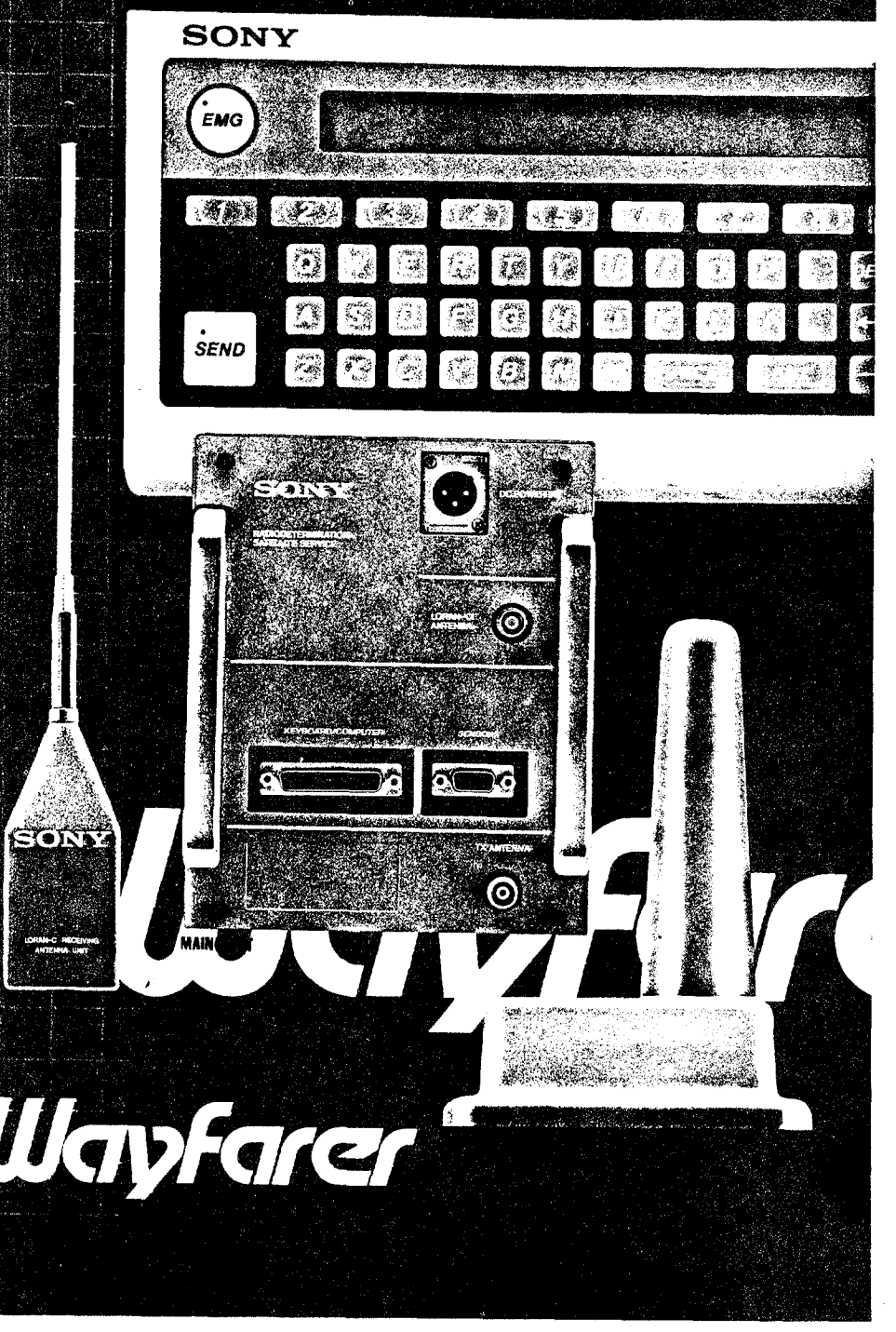
Sony RDSS (203).....E-1

II Morrow VTS (236).....E-2

Rockwell Positioning System (256).....E-3

SONY

If you own, operate, or dispatch a fleet of long-haul trucks, you probably know about the tremendous benefits of Radiodetermination Satellite Systems. With RDSS, your dispatch center can—for the first time—track the precise location and status of every truck in your fleet. The Sony Wayfarer™ Mobile Communication Unit represents the first link in the Sony RDSS chain: the hardware that rides in the truck itself.



Wayfarer

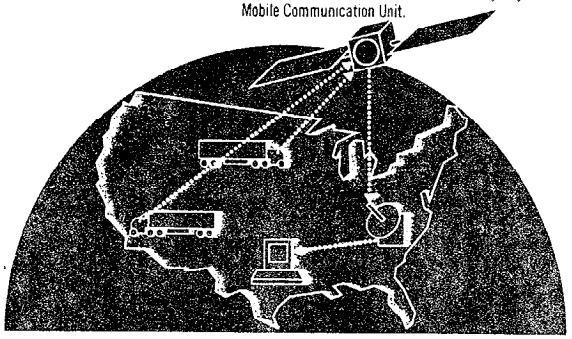
SONY RDSS

[redacted]

Wayfarer

THE SONY 'WAYFARER'™ MOBILE COMMUNICATION UNIT

The world's most advanced positioning and reporting system. RDSS. can help you eliminate wasteful out-of-route miles. trim deadhead miles. slash operating costs. increase your revenue and provide the best possible customer service. RDSS encompasses the Federal Government's Loran-C navigation network. GEOSTAR® satellite relays and centralized earth station. a ground link to your operations center. and computerized mapping software. But the RDSS story begins with the hardware that mounts in the truck: the Sony Wayfarer™ Mobile Communication Unit.



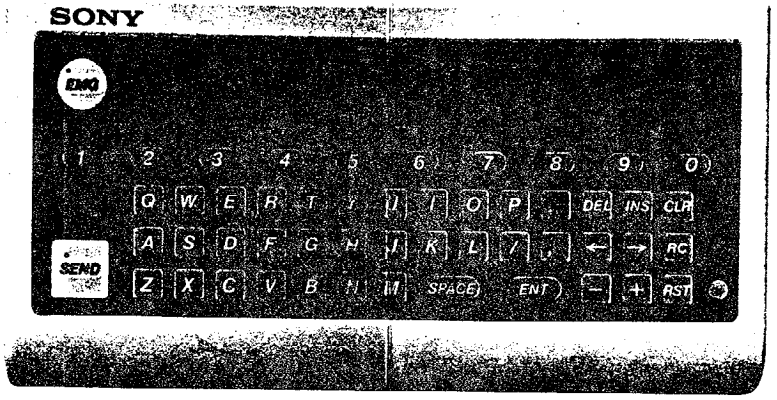
THANKS TO A THOUGHTFUL "MENU," IT TAKES ONLY SECONDS TO SEND A MESSAGE.

Rugged. reliable. and easy to use. the Wayfarer hardware was designed and built expressly for the rigors of long-distance trucking. Protected against the heat. cold. and humidity . . . the bumps. thumps. and vibrations. After all. the Wayfarer components were created by a recognized leader in mobile electronics: Sony.

For the easiest possible installation. Sony designed the Wayfarer as four individual components. each of which can fit in a variety of locations in and around the cab. These components are the Loran-C Antenna, the Main Unit. the Keyboard/Display. and the Transmit Antenna.

THE LORAN-C ANTENNA

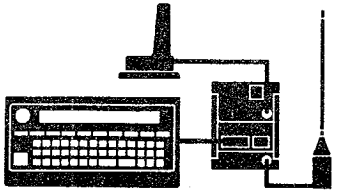
The Wayfarer™ Mobile Communication Unit's Loran-C Antenna looks like a short CB aerial—and mounts with similar ease. This antenna. with built-in preamplifier, picks up navigation radio signals from the Government's network of Loran-C transmitters throughout the continental U.S. These signals are fed to a tiny computer in the Main Unit that calculates position with amazing accuracy.



THE MAIN UNIT

The brains of the Sony Wayfarer is the Main Unit, a "black box" that requires no attention from the driver. It can mount in the tool compartment or another unobtrusive location. It measures just 5⅞ (W) × 9⅞ (H) × 7⅛ (D) inches, but don't let the size fool you. The Main Unit contains all of the positioning, transmitting and computing electronics. For the easiest possible trouble-shooting, the Main Unit contains a built-in diagnostics program.

In addition to automatic vehicle location, the Main Unit can attach to vehicle sensors to transmit such on/off information as engine overheat, oil low, door open, reefer temperature too high, burglar alarms, and the like.



THE KEYBOARD/DISPLAY

At Sony, we believe a driver's time and attention is best spent driving. Not making unnecessary stops, not waiting for instructions or assistance, and definitely not leafing through instruction manuals, studying computer programs, or typing. That's why we designed the Wayfarer to transmit vehicle location and sensor readings automatically. For these transmissions, the driver need not touch a single button.

When the driver wants to send a message to central dispatch. the Wayfarer Keyboard/Display makes it quick and easy. The Display prompts the driver with a handy

[redacted]

"menu" of message types: ARRIVED, LOAD, DEPARTURE, ETA, STATUS, and OTHER. The driver can select LOAD, for example, at the touch of a single button. The next display prompts him for FULL, LESS THAN FULL, or EMPTY. If the driver selects either of the first two, he is then prompted to enter LOAD NUMBER, WEIGHT/CUBES/ or UNITS and load description.

[redacted]

In the same way, the driver can send off a quick ETA message based on prompts for DATE, TIME, and DESTINATION. Plus, the STATUS option includes prompts for HOURS AVAILABLE, ROAD CONDITION, WILL CALL, and FUEL.

Prompted step-by-step, the driver can send most messages in a matter of seconds. For breakdowns, emergencies, delays and special situations, the driver can always add his own comments in his own words.

[redacted]

At only 8¹⁴⁄₁₆ × 4⁹⁄₁₆ × 1³⁄₁₆ inches. the Keyboard/Display is small enough to fit anywhere in the cab. To make things easy. the Keyboard includes handy functions keys. in addition to the standard alphanumeric keys. The easy-to-read back-lit LCD Display (40 characters × 2 lines) lets the driver check and correct every driver-initiated message before sending.

THE TRANSMIT ANTENNA

The Transmit Antenna. a helical antenna with built-in high power amplifier. is the last component of the Wayfarer Mobile Communication Unit. Only 9 inches high and 7½ inches wide, it's powerful enough to send messages to the Geostar satellite in outer space.

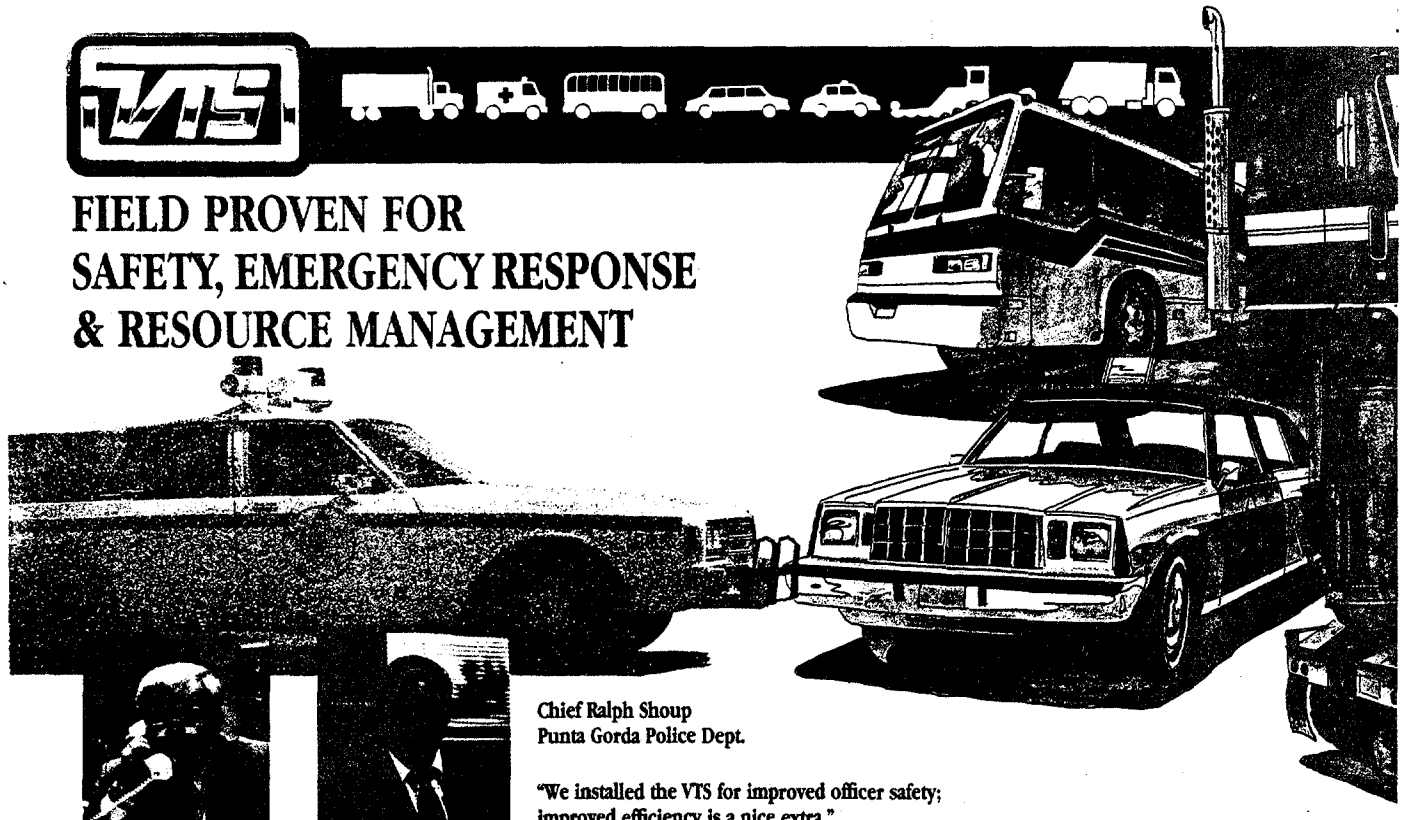
LIFE IN A TRUCK IS HARD. SONY WAYFARER IS BUILT TO TAKE IT.

GET UP TO SPEED

RDSS represents your best opportunity to get your fleet communications up to speed. And Sony represents your best opportunity to get up to speed with RDSS. Not only do we sell the mobile hardware, we service it and we offer driver and operations training. Plus, Sony can get you hooked up to the GEOSTAR™ satellite service. assist you with operations center computers. and get you started with customized RDSS computer software.

E-1.2

FIELD PROVEN FOR SAFETY, EMERGENCY RESPONSE & RESOURCE MANAGEMENT



Sheriff Donald Breaux
Layfayette Parish Sheriff's Dept.

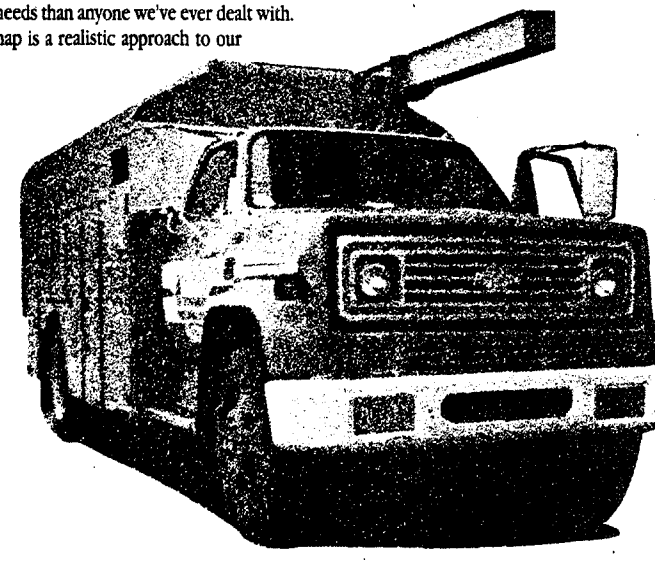
"In the future, VTS will save somebody's life."

Officer safety, along with faster response, were the two main reasons Sheriff Donald Breaux installed a VTS in his department's fleet. Fifty VTS equipped vehicles now give the 269 mile area improved mobile resource management, reduced response time, and increased officer safety.

Chief Ralph Shoup
Punta Gorda Police Dept.

"We installed the VTS for improved officer safety; improved efficiency is a nice extra."

"II Morrow personnel have been more responsive to our needs than anyone we've ever dealt with. Their big screen map is a realistic approach to our problems."

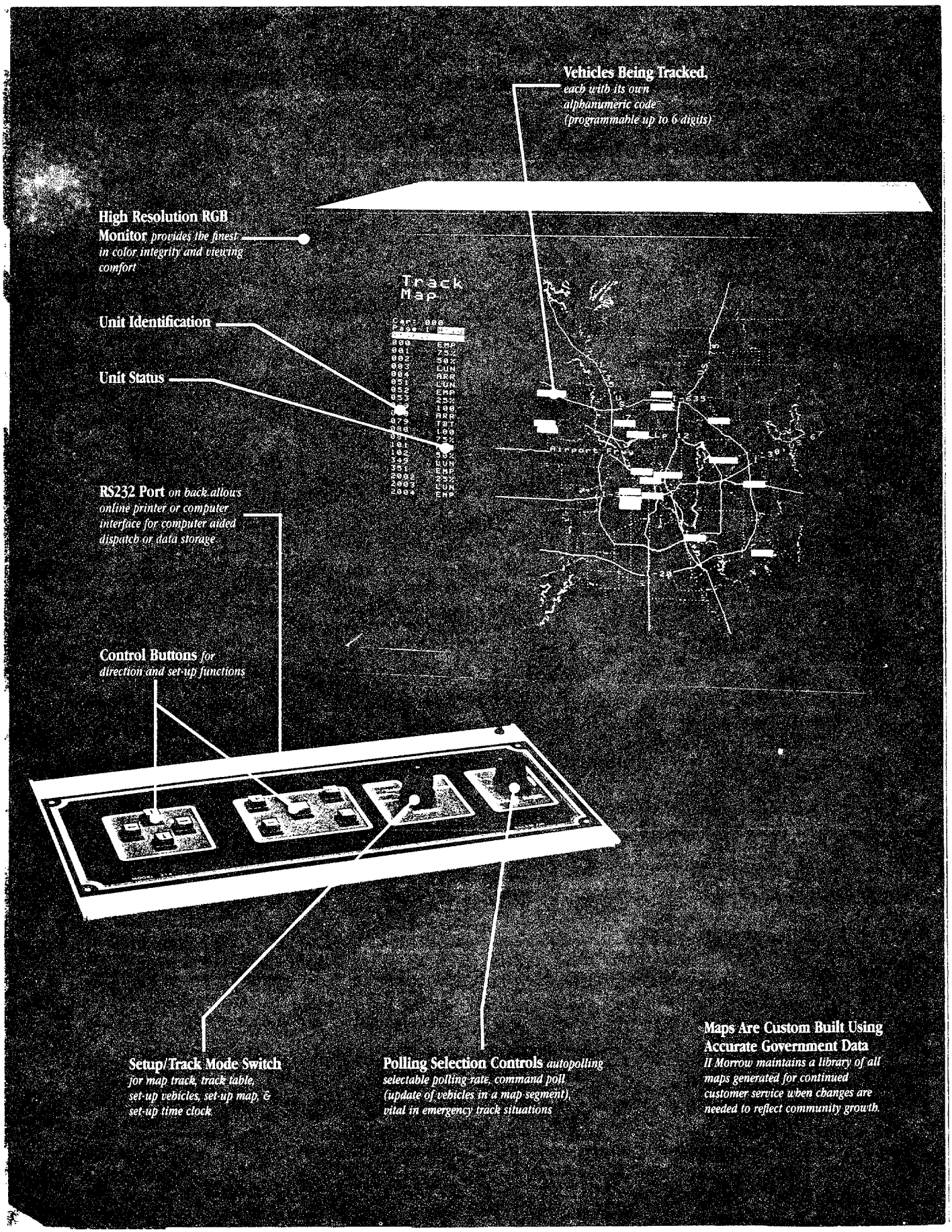


Bill Volk
Champaign, Urbana Mass Transit Authority

"VTS gives us the ability to pinpoint the exact location of a bus in case of an emergency."

Concerned with adding extra protection for bus drivers and passengers, 53 buses were equipped with VTS. In a co-ordinated effort with local police, VTS enables fast response to an exact location.

Plus, fewer street supervisors can now do more productive work.


Vehicles Being Tracked, each with its own alphanumeric code (programmable up to 6 digits)
High Resolution RGB Monitor provides the finest in color integrity and viewing comfort
Unit Identification
Unit Status
RS232 Port on back allows online printer or computer interface for computer aided dispatch or data storage
Control Buttons for direction and set-up functions
Setup/Track Mode Switch for map track, track table, set-up vehicles, set-up map, & set-up time clock
Polling Selection Controls autopolling selectable polling rate, command poll (update of vehicles in a map segment), vital in emergency track situations
Maps Are Custom Built Using Accurate Government Data
II Morrow maintains a library of all maps generated for continued customer service when changes are needed to reflect community growth.

How The System Works . . . It's Easy To Learn And Use.

The II Morrow VTS, (Vehicle Tracking System), is a Loran C based system which monitors the location and movement of a fleet of vehicles from your command center.

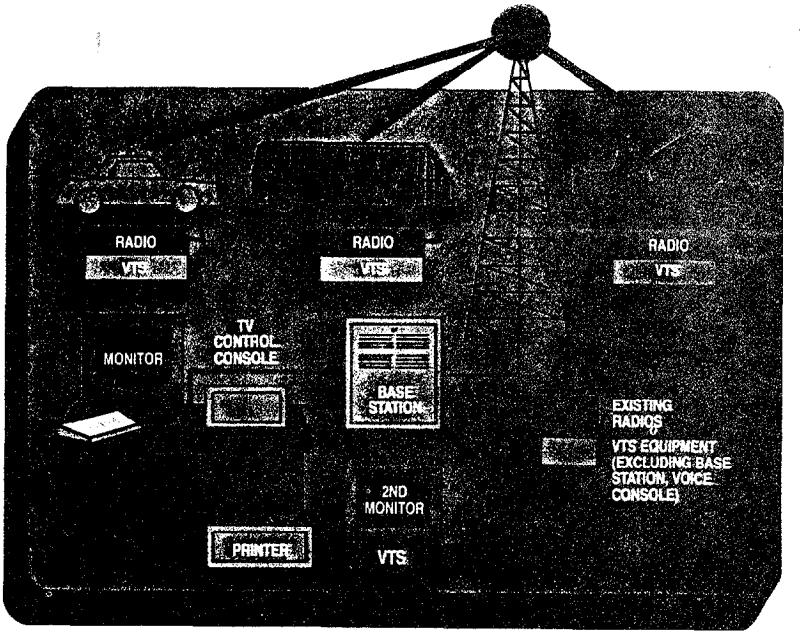
A II Morrow loran receiver is the "heart" of the VTS System. This receiver is mounted in each vehicle, and often may be tied into any existing radio transceiver, simply and affordably. The receiver picks up positioning signals from a U.S. government operated navigation network. Accuracies of 60′ to 100′ are common with the II Morrow VTS.

The VTS Control Console polls the vehicles in turn using the existing base station transmitter at the Control Center.

The on board transceiver responds with its current location and status.

The VTS Control Console receives the digital signal, processes it and feeds it into a high resolution color TV monitor on which a map of the area is shown for visual display. **The polling process takes less than 2 seconds per unit.**

Each vehicle appears on the map as a rectangle with the vehicle's alphanumeric code, (up to 6 digits). The system can track any size fleet.



The VTS system may be tied into any existing radio system, simply and affordably. In addition to tracking your fleet on a large TV monitor, CAD Interface provides invoicing, measure stand-by time, payroll, management controls, and vehicle and employee efficiency.

Silent Alarm

In addition to providing positive indication of the message transmission, the status transmitter includes a silent alarm button, and is backlit for easy night operation.

When the silent alarm is activated there is no indication in the vehicle and the alarm continues to transmit until a receipt signal is received. This silent alarm will transmit even if the vehicle's radio is turned off.

Variable Unit Identification

II Morrow's VTS accommodates virtually any existing unit identification scheme, providing you the ultimate in flexibility.

Up to a six digit alphanumeric code can be entered in the Control Console's vehicle setup matrix for tracking, or ID codes may be entered at the Control Console or at a remote location in the same building.

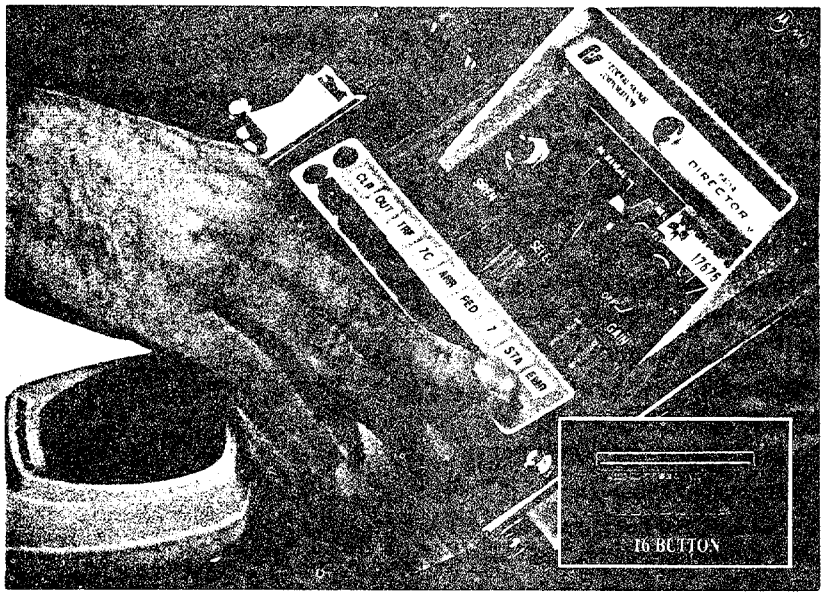
Features and Benefits

The VTS Control Console provides a wide variety of useful operational data including vehicle status, menu for quick map selection, reticle to magnify map area, and track table which provides offset distances of vehicles from known reference points, (see photos at right).

Status Transmitter Allows Fast Communication By Just Pushing A Button

A **status transmitter,** (8 or 16 button), located inside the vehicle allows the operators to **communicate their activities,** (unloading truck, loading, enroute, standby, etc.), **rapidly with Control Center without voice communications simply by pushing a button.**

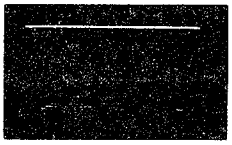
This gives dispatchers more time to handle more important things, instead of spending all their time on the radio with drivers. Some VTS users report it requires less dispatchers or supervisors to handle the same amount of vehicles.



The status transmitter inside the vehicle allows operators to communicate their activities rapidly with control center, without voice communications, simply by pushing a button.

The II Morrow Loran C Receiver Is The "Heart" Of The VTS

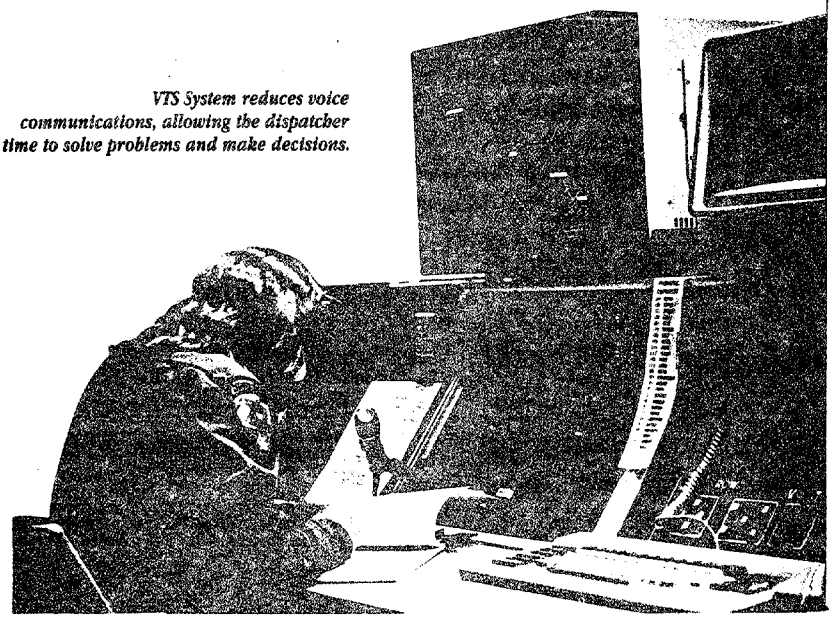
The II Morrow loran c receiver is the best in the world. That's why II Morrow is the leader of the loran industry and the **largest aviation loran manufacturer in the world.**



Our proven, completely solid state loran receiver combines sensitivity with ruggedness. It will track vehicles in marginal conditions ... accurately and reliably.

Other Features Of The VTS System Include:

- Factory tested for vibration and extremes of heat and cold.
- Tracks at speeds of over 600 mph.
- Meets or exceeds MIL-STD-810D.
- Tracking accuracies of 60′ to 100′ are common.



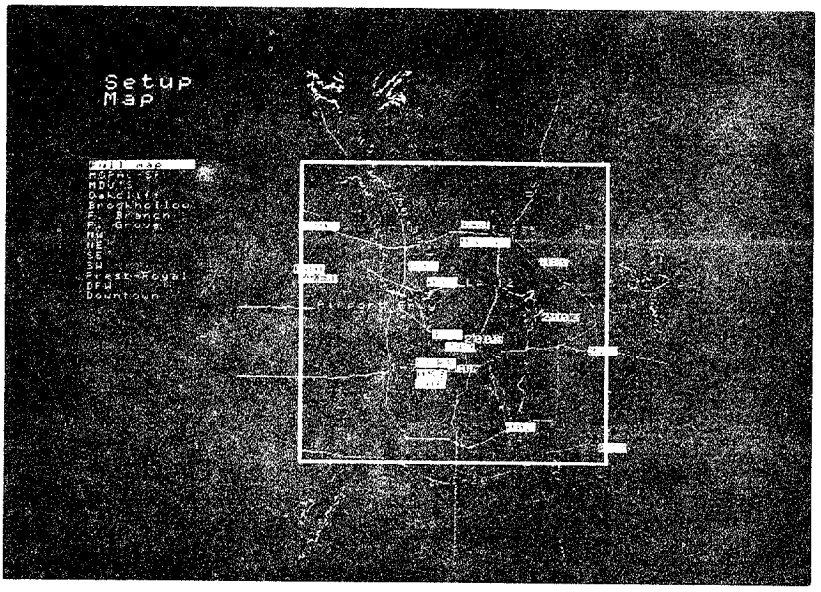
VTS System reduces voice communications, allowing the dispatcher time to solve problems and make decisions.

C.A.D. Interface

The Real Time Data on the TRACK TABLE, which provides the vehicle's location and status, can be instantly transferred, via RS 232 output, to another computer system or printer.

Analysis of vehicle standby time, travel time, and efficiency can be instantly accomplished.

Format and logic can easily be developed for measurement of operator performance and management controls. **Payroll, invoicing and operator reports can be instantly recorded as the events occur.**

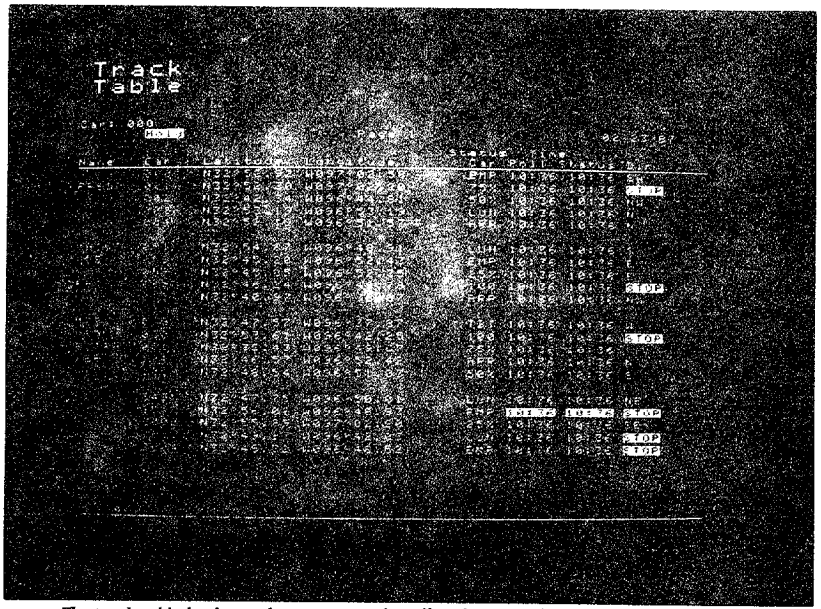


A large menu (left side of screen), allows quick map selection. The reticle can be adjusted to further magnify any selected area to fill the screen for greater detail.

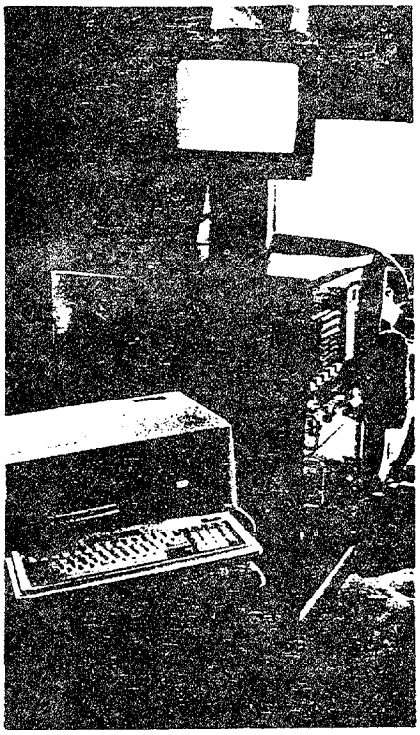
Emergency Track . . . This Picture Saves Lives, Time & Money!

A silent **Emergency Distress Signal** can be sent, (top right photo), located in the vehicle.

Upon receiving the Emergency Distress Signal the monitor at Central Control automatically **redraws the map** placing the vehicle in the center, **the vehicle in distress turns to red, an audible alarm is activated, and vehicles in the vicinity are quickly updated.**



The track table backs up the map, provides offset distances from known reference points, and gives time of last poll and time of last status change.



traveling across the eastern U.S. Equipment in the vehicle included a satellite transceiver, antenna and a computer with software developed by Rockwell.

A hotel meeting room served as the base station. A computer terminal displayed vehicle location on a video map. Messages were transmitted to and received from the vehicle, giving the audience a chance to see features such as automatic acknowledgement of message receipt.

Rockwell's Collins Avionics Div., based in Cedar Rapids, IA, and its Automotive Electronics business in Troy, MI, are jointly researching the technical, operational and marketing issues of satellite communications technology. They are also testing commercial viability of the Rockwell system which potentially could be available by the early 1990s.

Dennis Kline, director of marketing and planning, Automotive Electronics, said the system could enable fleets to track vehicles around the clock and communicate back and forth with their drivers. It could also be used to extract information from on-board computer systems, such as Rockwell's Tripmaster.

Other benefits include precise scheduling of freight deliveries, improved tracking of drivers' hours of service, and a reduction in phone bills, which, according to Rockwell, usually average $2,500-$3,000 a year.

Rockwell's Collins Avionics Div., formerly Collins Radio Co., achieved the first two-way radio voice communications via satellite in 1960 and has since been involved in the development of satellite communications systems for the U.S. military.

Circle 308 on Reader Action Card

ROCKWELL PREVIEWS SATELLITE SYSTEM

Attendees of the American Trucking Assn.'s Annual Management Conference and Exhibition, held recently in New York, got a sneak preview of a two-way satellite communications and position system under development by Rockwell International. Company officials said this is the first application of such a system.

The demonstration used an existing commercial satellite for two-way land-mobile communications and positioning of a specially equipped vehicle

Appendix F. Vehicle Safety Systems; Selected Literature

CarVision 9300 (205).....F-1

Model 750 (226 A).....F-2

Eagle Eye (229).....F-3

Automotive Watchcam (231).....F-4

CARDAR (238).....F-5

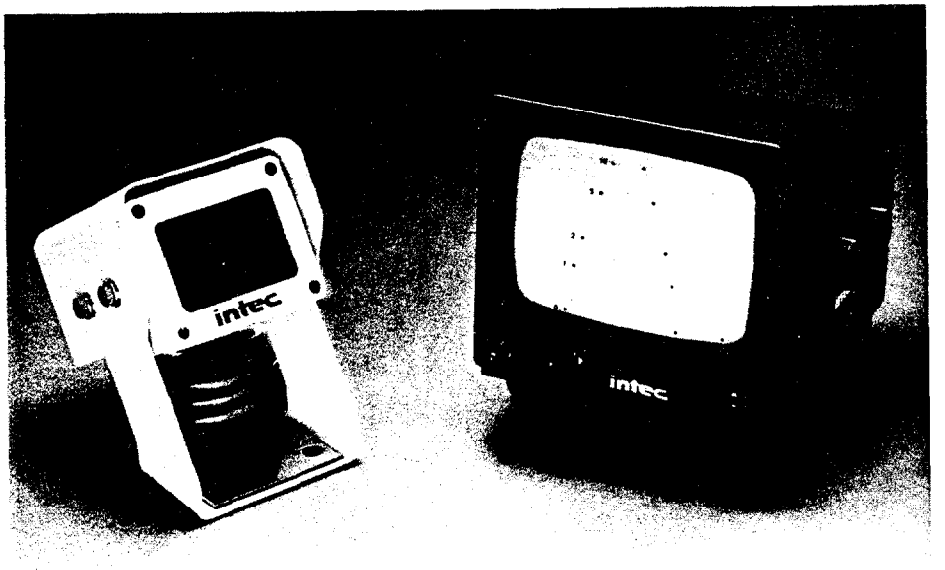
Retroguard (241).....F-6

Tattletale (245).....F-7

EBS1013 (247 A/B).....F-8

Backsensor (265).....F-9

intec®
Car Vision Systems



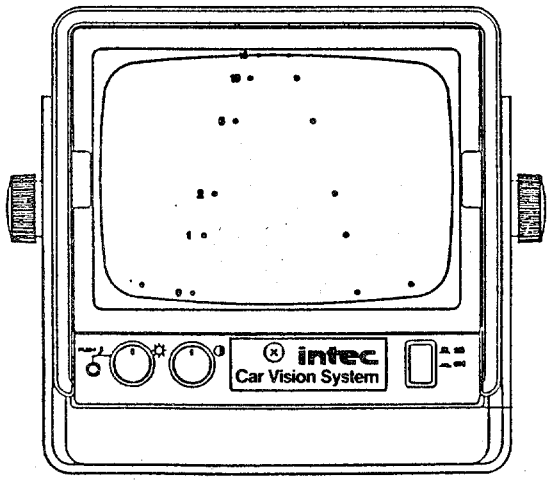
Operation Guide
Model 9300

We are gratified that you have selected an Intec Car Vision System. Before using your System, please be sure to read these instructions carefully.

OPERATION INSTRUCTIONS

POWER

Your Car Vision System should be installed so the ignition switch or power switch that controls your vehicle power also controls the power to the Car Vision System. It will take approximately 15 seconds for the System to warm up once the power is turned on. It is not necessary to push the ON—SB switch to the "ON" position when first starting the engine. In the "SB" (Standby) mode the System will automatically come on when the vehicle is put into reverse gear. This Instant On capability for reverse gear will allow you to leave the System in "SB" mode most of the time. It is advised that you set up your monitor by adjusting the Brightness, Contrast, and Day / Night controls before you begin driving as this will avoid unnecessary distractions while driving.



CONTROLS

The ON—SB push button sets the System in either a constant ON or Standby mode. In the Standby mode the System is kept in a ready state that will allow it to provide a picture instantly should the vehicle be put into reverse gear.

The Brightness and Contrast control knobs function very similar to those on a television set by increasing or decreasing the brightness and contrast of the picture to a desirable level.

The Day / Night switch should be set in accordance with the existing light condition. It is located on the brightness knob and is activated by pushing in. A green L.E.D. indicates the night setting.

SAFETY FUNCTIONS

Monitoring the rear view of the vehicle while backing up is accomplished automatically, provided the reverse gear circuit is engaged by connecting the blue wire on the monitor to the reverse gear switch. A picture will appear on the monitor as soon as the vehicle is placed in reverse gear when the monitor is in the SB (Standby) mode.

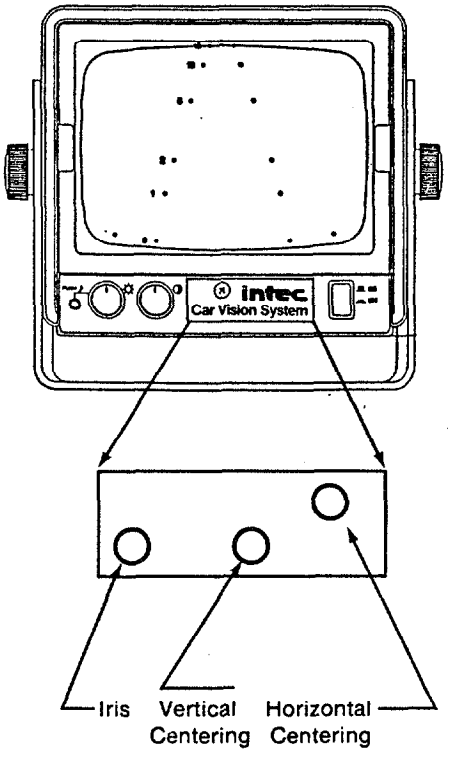
Monitoring the rear view is also helpful at times when in a forward gear. By moving the ON—SB switch to the ON position you will activate the System in a forward gear. This is very helpful when changing lanes, maneuvering in heavy traffic, monitoring a towed vehicle, or when driving in any area where children are present. Please note that the optional back-up lights do not function in the forward gears, only in reverse.

ADJUSTMENTS

V. CENTERING —
adjust to vertically center view.

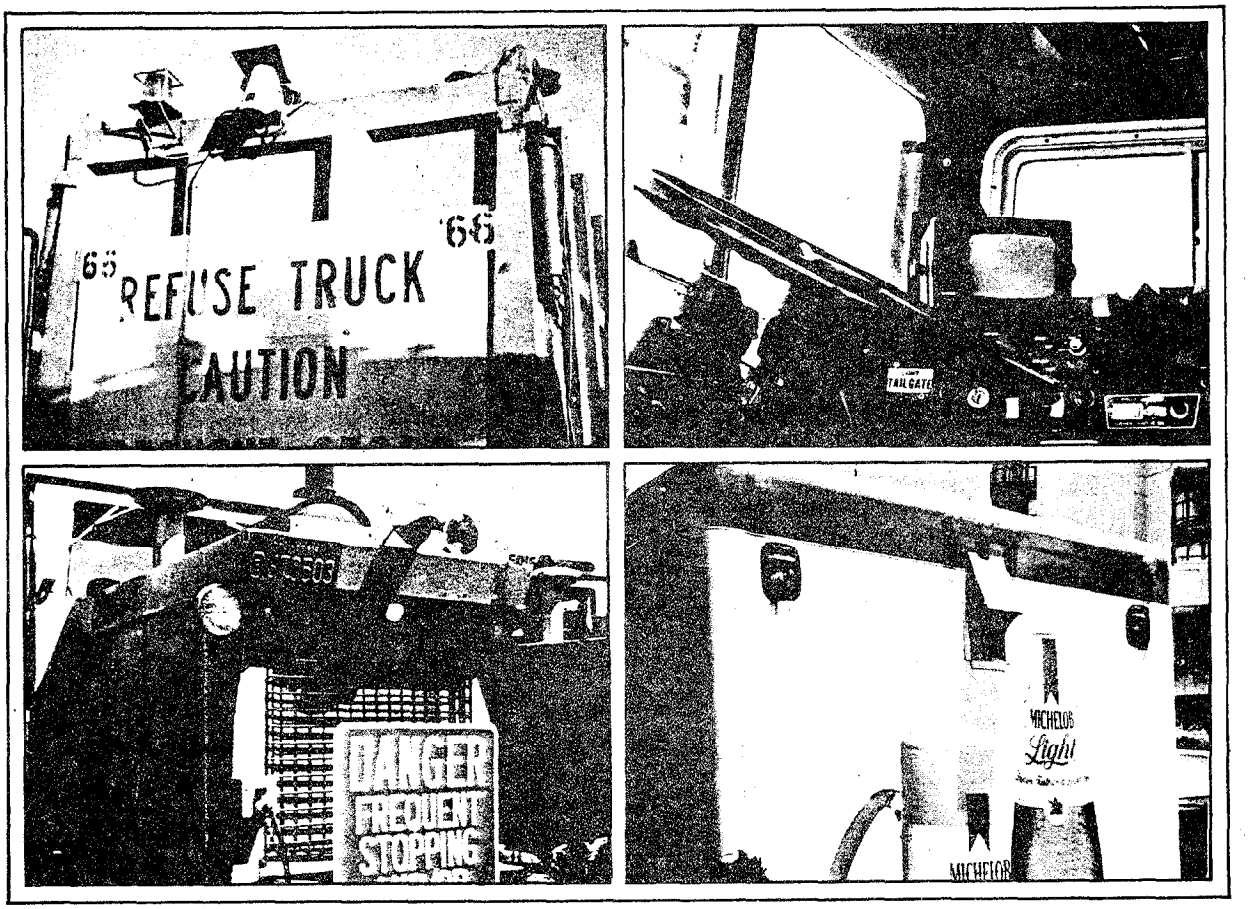
H. CENTERING —
adjust to horizontally center view.

IRIS —
adjust to set light level of automatic iris in camera lens. The lens will automatically close and open to maintain this reference setting.



PREVENT COSTLY ACCIDENTS, INCREASE PRODUCTIVITY WITH

CAR VISION by intec®

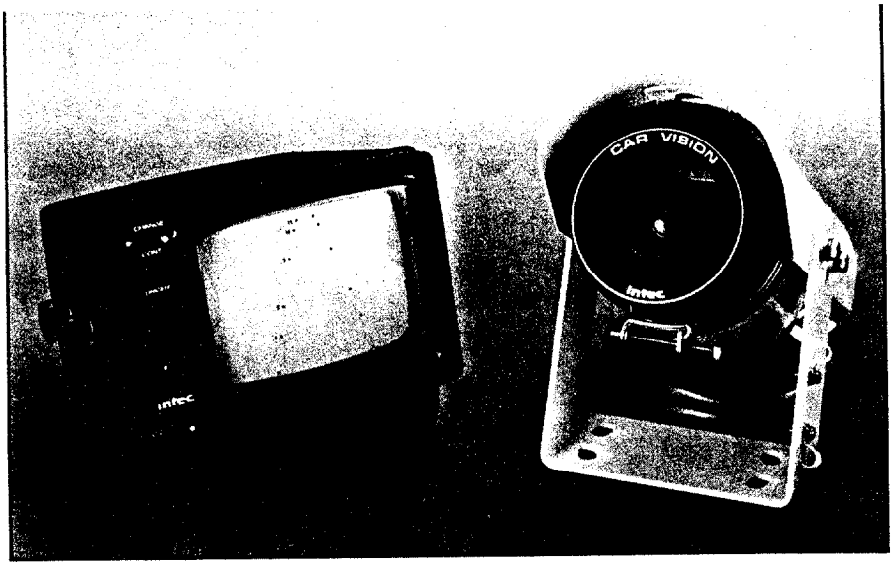


FEATURES AND OPTIONS

- "Car Vision" provides a clear view behind the vehicle with its ultra-wide angle lens.
- The system automatically comes on during backing and is a tremendous help when changing lanes in traffic.
- The compact TV monitor can be installed easily in the vehicle's cab.
- The system can withstand shocks of up to 4.4G's and will not resonate with any type of vibration from the vehicle.
- The camera is completely air-tight and water-proof and is designed for operation in all types of weather conditions.
- It does not rely on a sensor device, but lets the driver see what is behind him.
- Safety
- Available for refuse vehicles, compactors, highway maintenance, emergency, and other heavy duty vehicles.
- Optional camera heater and defogger glass for extreme weather conditions.
- 25mm lens for a close-up view.
- Standard 54 ft. cable with connections. Available in longer or shorter lengths to suit application.
- Optional back-up light kit with pedestal or flush mounts.

FOR SAFE VEHICLE OPERATION, DEPEND ON THE "CAR VISION" SYSTEM

MEETS CAL/OSHA REQUIREMENTS



SPECIFICATIONS

MONITOR

Power Source: 10-40 VDC
Model 9200 Standard Version
Model 9200T Trailer Version
Power Consumption: 20 Watts
CRT: 6" Diagonal (instant-on type)
Weight: Less than 9 lbs.
Color: Black, ABS with steel mount

CAMERA

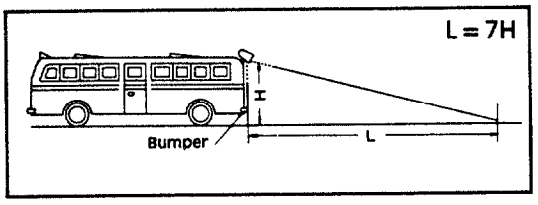
Pick-up Tube: 1" 7262A High sensitivity Vidicon
Video Signal: 1.5V p-p
Output Impedance: 40 Ohms
Scanning: Random Interlace
Automatic Light Compensation Circuitry:
Day 100-100,000 lux
Night 5-1,000 lux
Lens: 6.5mm f1.8
Weight: Under 8 lbs.
Color: Umber white, aluminum enclosure and mount
Cable: Standard Version—54' with connectors
Trailer Version—54' and 20' sections with weatherproof quick connectors

OVERALL

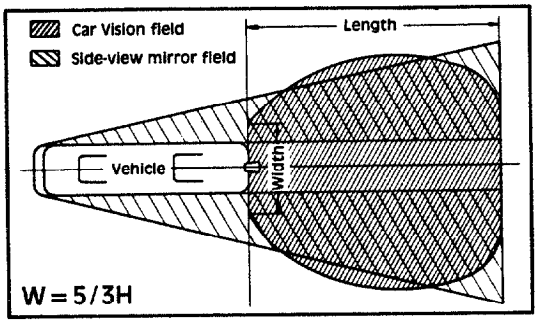
Operating Temperature:
5° to 131°F
(-17° to 131°F with optional heater and EC lens cover)
Vibration: Withstands constant vibration of 0 to 33 Hz
Shock: Withstands to 4.4G's
Weather Conditions: All

FIELD OF VIEW

Length of field



Width of field

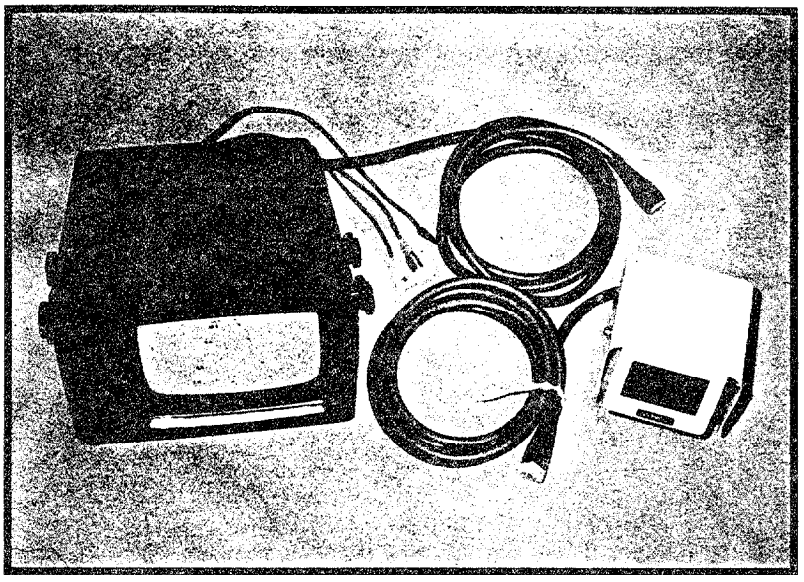


intec®

23301 Vista Grande
Laguna Hills, CA 92653-1410
(714) 859-3800

Distributed by:

MOTORHOMES
SCHOOL BUSES
REFUSE TRUCKS
FIRE EQUIPMENNT
DELIVERY VEHICLES



LIMOUSINES
YACHTS
VAN CONVERSIONS
CONST. EQUIP.
AIRCRAFT

TECHNICAL SPECIFICATIONS

CAMERA

RESOLUTION: 250 lines horizontal
350 lines vertical

AUTOMATIC ILLUMINATION:
5-100,000 Lux

FIELD OF VIEW: 100° horizontal
75° vertical

PICK-UP DEVICE: Interline transfer
CCD (8.8 x 6.6 mm)

LENS: 4.8 mm F1.8 - F100
Auto-iris

DIMENSIONS: W x H x D
3.5/16" x 2.11/16" x 3.7/8"
(main enclosure assembly)

WEIGHT: Approx. 1.0 kg.

MONITOR

CRT: 6 - inch (instant on type)

CONTROLS: Day/Night, On/Standby, Contrast, Brightness, Vertical/Horizontal hold, Lens iris remote control adjustment

DIMENSIONS: W x H x D
(7.3/4" x 5.5/8" x 8.1/4")

WEIGHT: Approx 4.0 kg.

SYSTEM

POWER SUPPLY: 10 to 40 VDC

AMBIENT CONDITIONS: -10 to +50°C
All weather conditions

The 9300 **INTEC** Car Vision System continues in the tradition of quality **INTEC** products designed specifically for the environment in which they are used. **INTEC'S** committment to customer service means the products are backed by years of video experience and our knowledgeable staff.

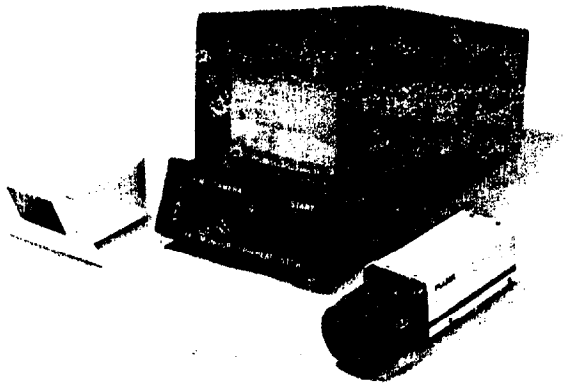
intec® VIDEO SYSTEMS, INC.

23301 VISTA GRANDE • LAGUNA HILLS • CA 92653 • (714) 859-3800

AUDIT®

MODEL 750

REAR CAMERA VIDEO SYSTEM

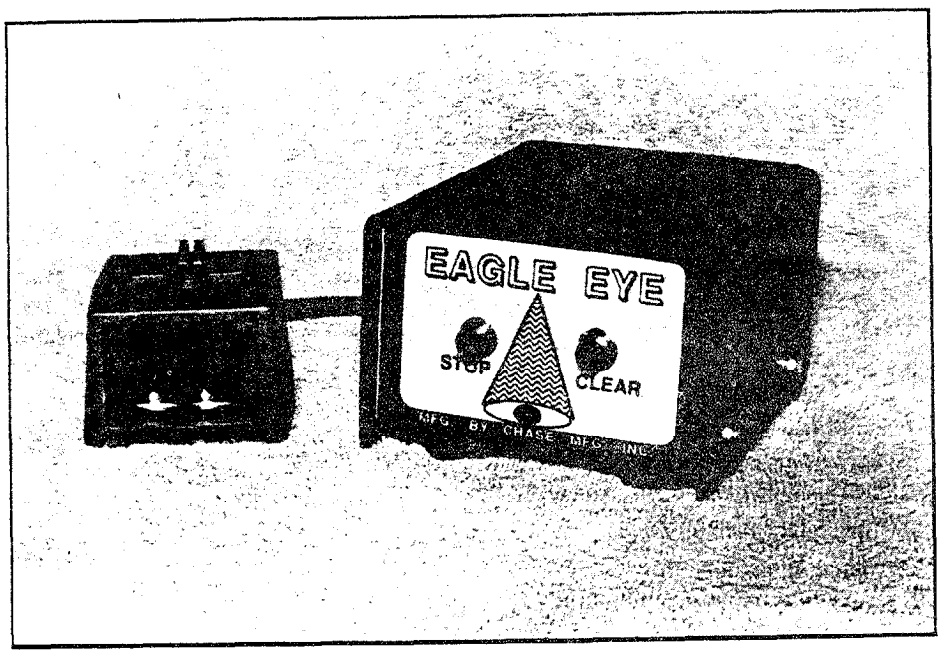


INSTALLATION MANUAL

JAVELINA CORPORATION
RT 2 BOX 322
FRISCO, TX 75034
(214) 377-9807 TLX: 820167

EAGLE EYE

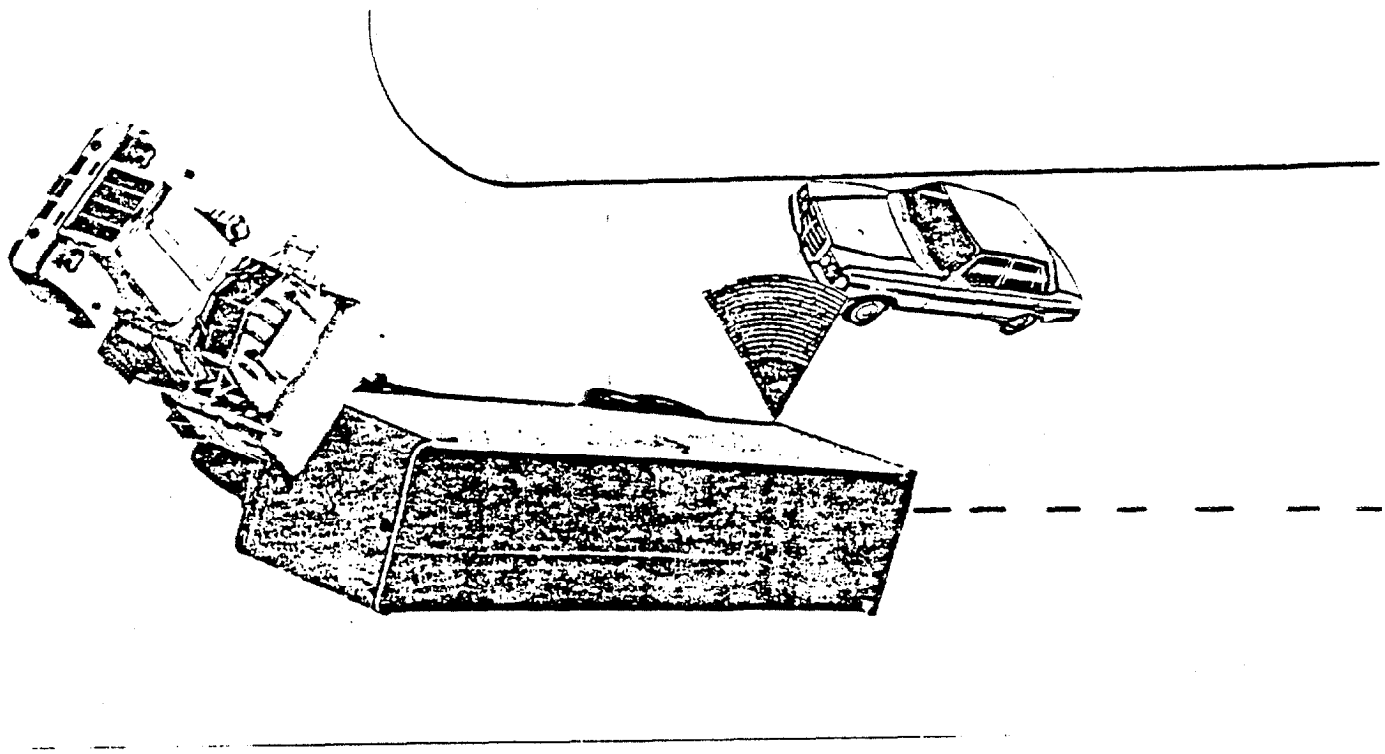
Avoid The Crunch of Blind Spot Accidents

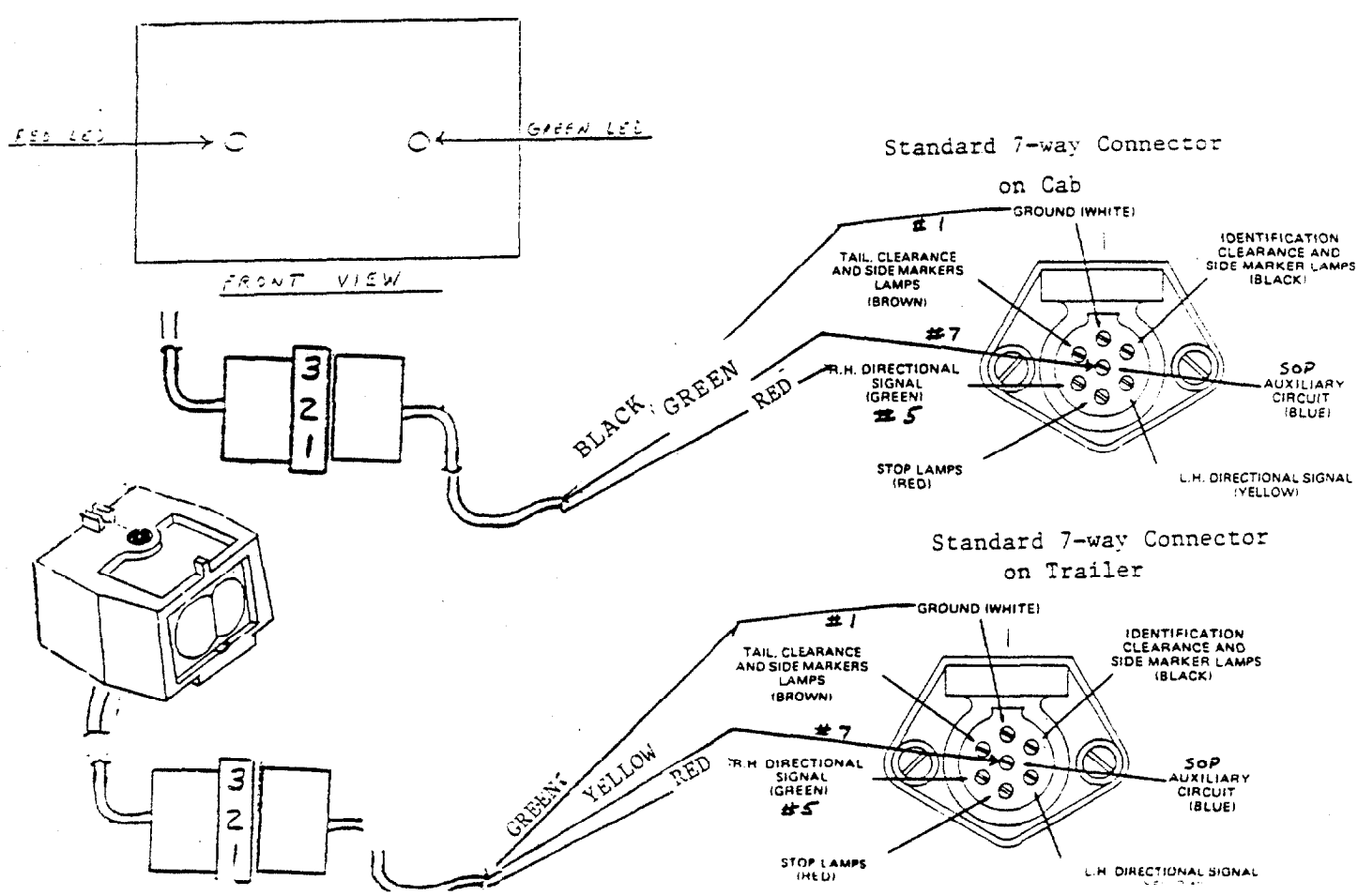


* Prevents right turn squeeze accidents
* Serves as a passing clearance indicator
* Great for all RV's
* Reduce Costly Insurance Premium
* Can be used as a back-up warning system
* Simple to install
* Easily affordable for owner operators
* Monitors both visual and audible warnings in your cab.

the eagle eye SAFETY DEVICE

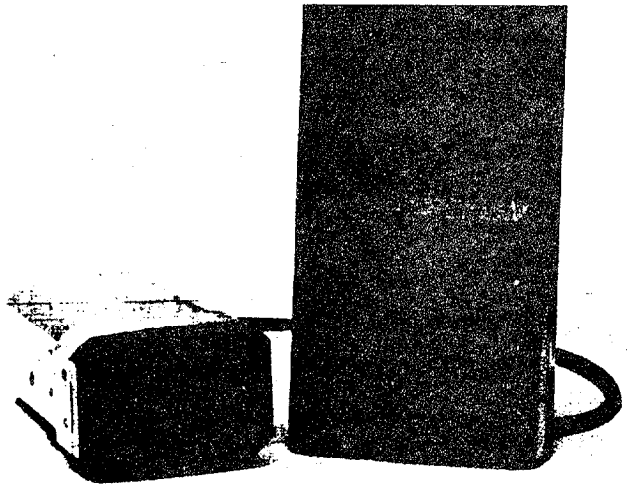
Patent Pending




RED LED
GREEN LED
FRONT VIEW
Standard 7-way Connector
on Cab
GROUND (WHITE)
#1
TAIL, CLEARANCE
AND SIDE MARKERS
LAMPS
(BROWN)
IDENTIFICATION
CLEARANCE AND
SIDE MARKER LAMPS
(BLACK)
#7
R.H. DIRECTIONAL
SIGNAL
(GREEN)
#5
SOP
AUXILIARY
CIRCUIT
(BLUE)
STOP LAMPS
(RED)
L.H. DIRECTIONAL SIGNAL
(YELLOW)
3
2
1
BLACK
GREEN
RED
Standard 7-way Connector
on Trailer
GROUND (WHITE)
#1
TAIL, CLEARANCE
AND SIDE MARKERS
LAMPS
(BROWN)
IDENTIFICATION
CLEARANCE AND
SIDE MARKER LAMPS
(BLACK)
#7
R.H. DIRECTIONAL
SIGNAL
(GREEN)
#5
SOP
AUXILIARY
CIRCUIT
(BLUE)
STOP LAMPS
(RED)
L.H. DIRECTIONAL SIGNAL
3
2
1
GREEN
YELLOW
RED

F-3.2

Rearview TV system engineered for use on large and special-purpose vehicles



TV monitoring system enhances peripheral and rear vision for drivers.

The Automotive WatchCam, a vehicular rear-vision TV monitoring system introduced by Sony Security Systems Co., a Paramus, N.J.-based division of Sony Corp. of America, is designed to provide fuller peripheral and rear vision for drivers of trucks, buses, and other vehicles.

SSS president John Garrison says his company's monitoring system overcomes problems inherent in rearview mirrors. "Rearview mirrors are limited in their line-of-sight nature," he says, "and thus do not provide adequate vision for today's large or special-purpose vehicles."

Because vehicle space is at a premium, the WatchCam system's designers reportedly made size an important consideration. The 4-in. monitor, FDM-412AM, is 1 3/16 in. deep, while the camera, HVM-312-SAM, measures 1 5/16x3 15/16 in. When encased in its water-resistant housing, the camera measures 2x3x6½ in. and weighs 22 oz., compared with 5x7x10¼ in. and more than 7 lb. for a typical automotive rearview camera, says Garrison.

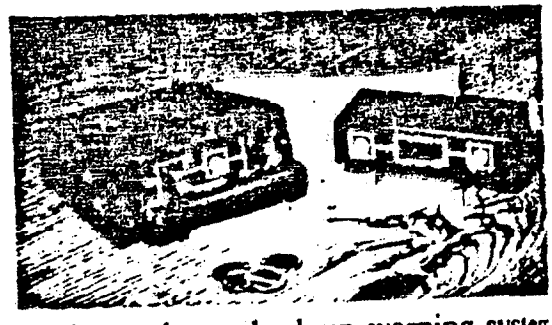
The camera, which is built to operate over a temperature range of –13° F. to 176° F., provides a wide viewing angle, 85° horizontal and 62° vertical. Both the camera and its housing are designed to dampen road-induced vibration and shock.

Hook-up is simplified by the system's use of a single coaxial cable that carries not only power and video but also audio. The latter is especially helpful for drivers being guided into particularly tight spots. Drivers can hear spoken directions even with the windows rolled up.

The system, which sells for $1,500, works off either a 12v or 24v DC power source and consumes 7.2 watts. *Circle 303 on reply card for more data*

Traffic Sensor

Cardar proximity warning system consists of a tiny remote sensor and a dash-mounted electronics module which work together to alert driver of other vehicles coming too close. System uses functional block electronics that emit a signal that echos off of too-close vehicles, allowing detection under almost any combination of adverse weather conditions and through blind spots. Driver is alerted by both an audio alert and a bi-color visual alert. Device



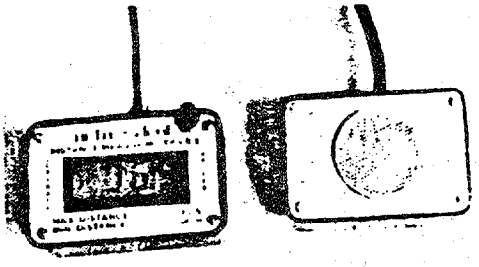
can be used as a back-up warning system when loading/unloading vehicles.

Yong Digital Electronics Co.

● Circle **256** on Reader Action Card ●

BACK-UP ALERT

Retro-Guard ultrasonic ranging device prevents back-up accidents by measuring and digitally displaying distance between rear of any kind of vehicle and objects within 10 feet. Device's 2 ultrasonic transducers, located on rear of vehicle, send out



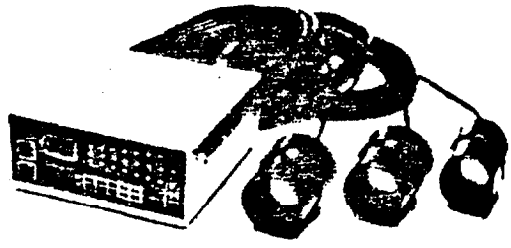
ultrasonic waves whenever vehicle is shifted into reverse. Microprocessor measures time of sound wave's echo, converts it into "real" time and sends information to digital display screen mounted on dashboard. Digital read-out starts at 10.5'. Device emits beeping sound once truck is within 5.9' of an object. When truck is about 23" from obstacle, beep turns into a continuous warning tone.

Dal Star Research Inc.

Circle **135** on Reader Action Card

Sonar Backup Unit

Tattle Tale automotive sonar backup protection system monitors objects 16' or closer to vehicle. System features 2 parts: 3 rear-mounted transducers to monitor path while backing vehicle, and a forward control console to relay the information. Console's complete range and area indicators allow both visual and audible warnings of



potentially hazardous objects in vehicle's path. • *Polytech Corp*

• Circle 239 on Reader Action Card •

ULTRASONIC
Sensing Systems
Help To
Prevent Accidents

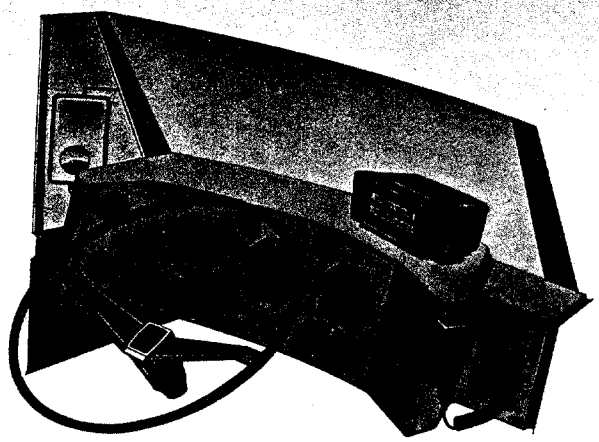
ULTRASONIC SENSING

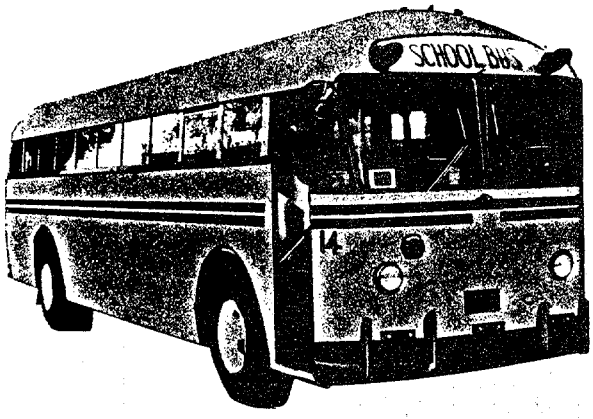
- Eliminates Blind Spots common to most Buses.
- Puts "Eyes" in the front and back your Buses.
- Senses obstacles unseen from the drivers seat. (Sees in total darkness and where mirrors can't)
- Monitor alerts driver with Audible and Visual Warnings
- Micro-Gain Technology - High Efficiency Solid State Sensors

AUTOMATIC OPERATION

The System will automatically begin scanning when the doors are opened, and turn off several seconds after closing the doors. Rear Sensors are activated when the Bus is in reverse gear.

The System alerts the driver with both Audible and Visual warning signals on the Display Monitor.





SIMPLE INSTALLATION

Modular plug together system is easily installed on existing vehicles or built into new coaches without the need of special tools or technical knowledge.

LOW MAINTENANCE

Weatherproof sensors only require being kept free of mud or ice using normal maintenance procedures.

AUTOMATIC OPERATION

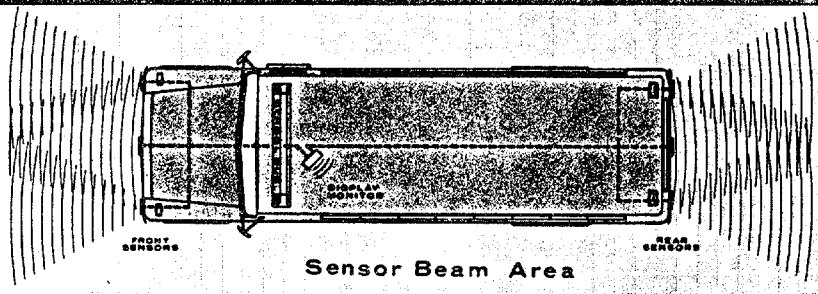
Does not require the driver to turn the system on or off.

EFFICIENT

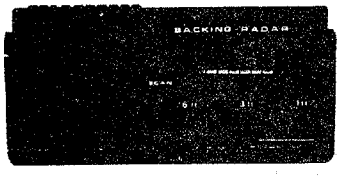
All solid state design for reliable cost effective accident and damage prevention.

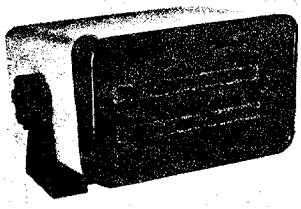
SPECIFICATIONS

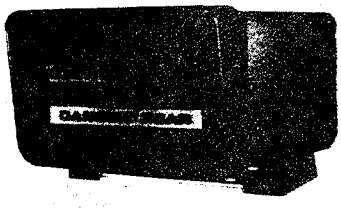
Beam Width - 10.5 feet (Nominal)
12.5 feet (Maximum)



Sensor Beam Area







Sensors ...(3 front, 3 rear)

Type	Ultrasonic - All Weather
Operating Frequency	40 KHz
Operating Voltage	12V (Neg. Ground)
Dimensions - Sensors	9.3 x 2.5 x 1.6"
Cable Length	15 ft. (front); 50 ft. (rear)
Operation	Automatic when connected to the door switch or transmission switch

Model 1013 - Single Display with colored light bar to monitor distance to object. Alerts driver at 6ft, 3ft & 1ft from object. For front or rear installation.

Model 3060 - Display flashes visual warning message and Audio alarm to driver when object enters the scanning area. Monitors both front and back of vehicle.

Model 3015 - Single systems for front or back detection only.

DEALER

FLEET SPECIALTIES CO., INC. • Box 4575, Thousand Oaks, CA 91359 • (818) 340-8181

BACKSENSOR™

High tech vehicle safety has always been an idea for the future. BACKSENSOR, a product of Safety Technology, Inc., brings the future to you now. BACKSENSOR is an ultrasonic rear view mirror that gives the driver the extra edge in safety.

The BACKSENSOR system consists of three sensors (two transmitters and one receiver) that are mounted on the rear of the vehicle. The electronically-controlled BACKSENSOR can continuously detect and display the distance of an unseen object when the vehicle is put into reverse. BACKSENSOR alerts the driver three ways:

1. an audible alarm
2. a precise distance readout to the object, and
3. helps track distance to loading dock.

The BACKSENSOR also automatically activates a loud beeper mounted on the rear of the vehicle. The BACKSENSOR increases driver safety and efficiency while reducing the chance of costly property loss personal injury liability.

Adjustable Range

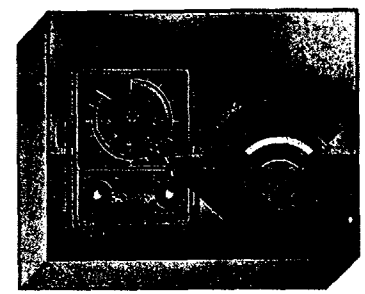
The adjustable range can be preset anywhere from 8" to 20', depending on the function of the vehicle and size of the work area.

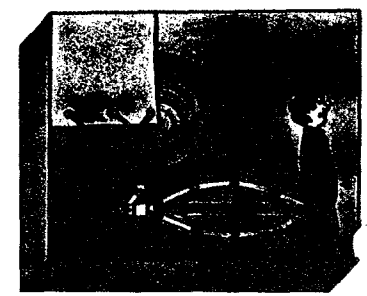
The driver can tell how far away an object is by the dash-mounted LED monitor. The monitor prevents a driver from making an incorrect distance-to-object estimate by providing accurate distance information.

Warning Beepers

An easy-to-install warning beeper in the driver's compartment notifies the driver the moment an obstacle enters within the pre-set detection range.

A second warning beeper, mounted on the rear of the vehicle, alerts the attention of people within the danger zone.





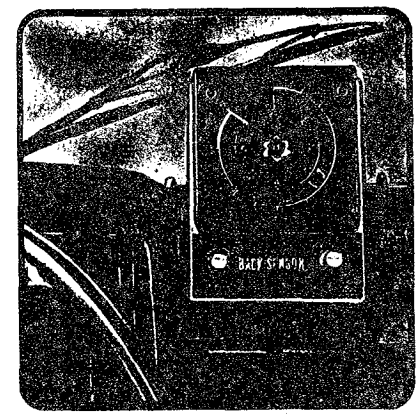
BACKSENSOR™ Ultrasonic Rear Surveillance System

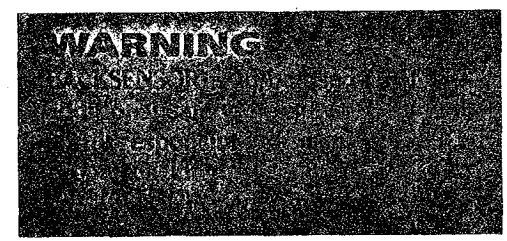
Principles of the BACKSENSOR

The BACKSENSOR operates on the principle that the speed of sound is a constant 1,115 feet per second. The system's two transmitters emit ultrasonic sound waves. When the waves detect an obstacle (a person or an object) behind the vehicle, they reflect back to the receiving sensor which activates the cab warning indicator. The time elapsed between the transmission and the receipt of the sound waves is electronically measured and converted into the distance between the rear of the vehicle and the obstacle. The information is displayed on the warning indicator and a warning beeper sounds.

Specifications of the BACKSENSOR

Power:	12V DC
Power On:	activated by reverse gear
Current Consumption:	.3 Amps
Frequency:	36kHz
Temperature Range:	−22°F to 150°F
Operational Range:	8 inches to 20 feet
Alarm Range:	8 inches to 20 feet
Volume of Rear Alarm:	95dB





SAFETY™ Technology, Inc.

Installation & Maintenance

The BACKSENSOR comes complete with mounting hardware. Installation on a truck usually takes less than one hour.

The solid-state construction remains unaffected by all weather conditions, can withstand temperatures from −22°F to 150°F, and works accurately both day and night.

To maintain in perfect working condition, simply remove the dust and dirt from the rear mounted sensors and wipe with a clean, wet rag when necessary. The BACKSENSOR is under warranty for one full year.

Complete, Easy to Install Kit Includes:

- a dash-mounted distance display monitor
- an in-cab warning beeper
- two transmitters (sensors)
- one receiver (sensor)
- an outside warning beeper
- one rear sending unit
- a heater switch for cold weather operation
- cables, and mounting hardware
- a one year limited warranty